Chocorua Watershed Project Phase II Quality Assurance Project Plan

Lead Organization: University of New Hampshire Center for Freshwater Biology

Prepared by:
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March 28, 2003

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Signature / Date
Arthur Clark, US EPA Region I

NHDES QA Officer: ______________________________
Signature / Date
Vincent Perelli, NHDES QA Manager

Document control number:

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3.0 Distribution List and Project Personnel Sign-off Sheet

Table 1 presents a list of people who will receive the approved QAPP, the QAPP revisions, and any amendments. A project personnel sign-off sheet is not included in this draft. It will be generated upon finalization of the QAPP, and all people related to the project will indicate they have read the QAPP before completing any work on this project.

Table 1. QAPP Distribution List

QAPP Recipient Name	Title	Organization	Contact Information: Telephone Numbers and email addresses
Jeffrey Schloss	Project Manager	UNH Cooperative Extension	603-862-3848 jeff.schloss@unh.edu
Robert Craycraft	Field Team Manager/Laboratory QA Officer / Quality Assurance Manager	UNH Cooperative Extension	603-862-3696 bob.craycraft@unh.edu
Joan Richardson	District Manager	Natural Resources Conservation Service	603-447-2771 joan-richardson@nh.nacdnet.org
Vincent Perelli	QA Manager	NH DES	617-271-8989 vperelli@des.state.nh.us
Andrea Donlon	Program QA Coordinator	NH DES Watershed Management Bureau	603-271-8862 adonlon@des.state.nh.us
Warren Howard	USEPA Project Manager	USEPA New England	617-918-1587 Howard.Warren@epamail.epa.gov
Arthur Clark	USEPA Quality Assurance Officer	USEPA New England	617-918-8374 Clark.Arthur@epamail.epa.gov

Based on EPA-NE Worksheet #3

4.0 Project Organization and Responsibility

The Chocorua Watershed Project Phase II, post Best Management Practice (BMP) effectiveness assessment, is a cooperative effort among local, state and federal groups/agencies. The two primary partners are University of New Hampshire Cooperative Extension (UNH CE) and the Chocorua Lake Association (CLA). The project manager, Jeff Schloss, is ultimately responsible for the final data review, interpretation of the water quality data and writing the final project report. The Quality Assurance (QA) manager, Robert Craycraft, has the overall responsibility of training the proper sample collection and watershed monitoring techniques to the CLA volunteer monitors. Robert Craycraft and Jeffrey Schloss are also responsible for training Center for Freshwater Biology (CFB) field team staff applicable sample collection and water quality monitoring techniques required as outlined in this proposal. Fixed lab samples for this project will be analyzed at the CFB laboratory. The data users may include local decision makers, lake, land and watershed associations, agency staff, advisory boards, educators and their students, researchers, conservation organizations, service groups, private consultants and interested citizens.

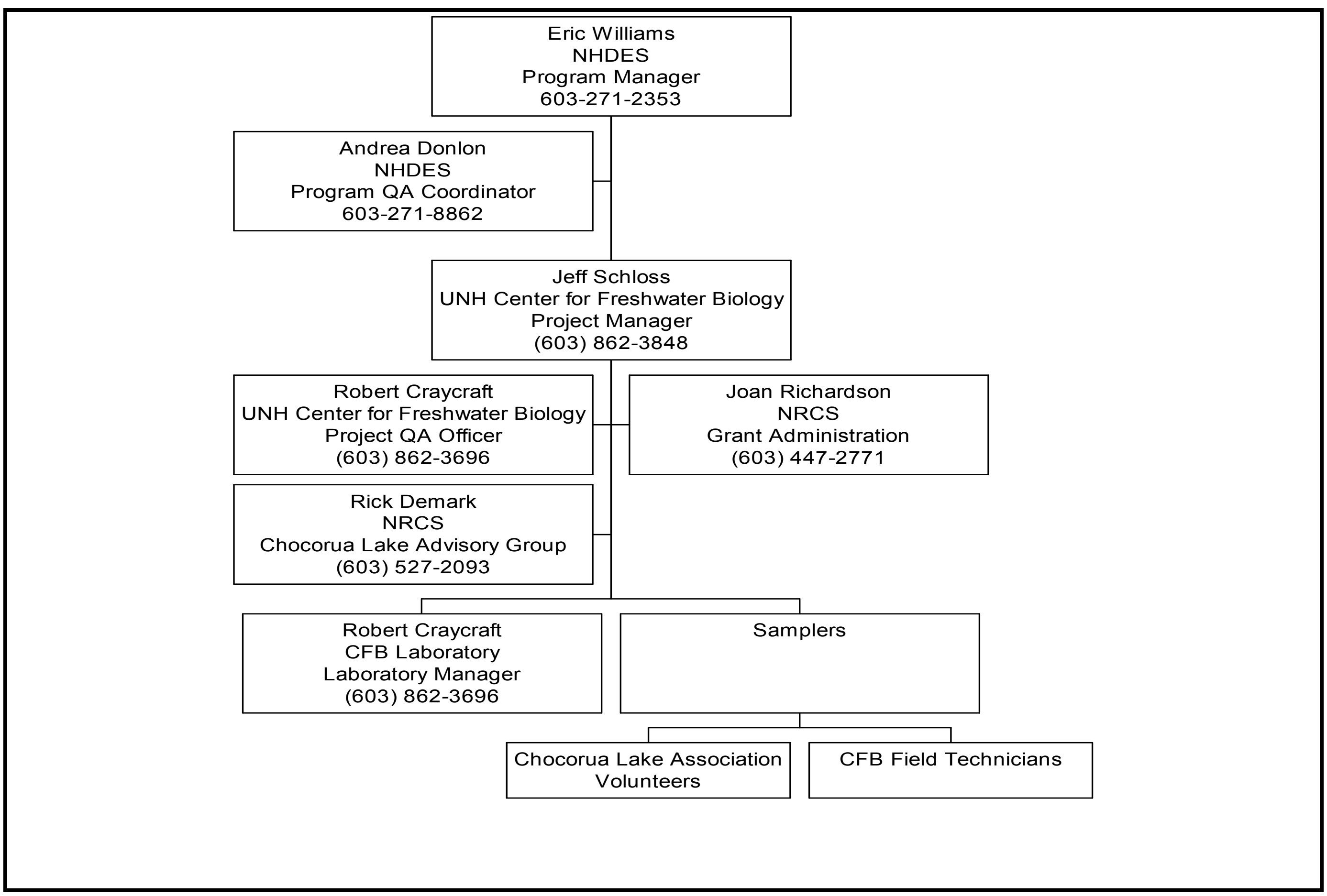
A pre-existing Chocorua Lake Project Team will be briefed of study findings and will be consulted for future monitoring and mitigation efforts. The Chocorua Lake Project Team is facilitated through the North County Resource and Conservation District and includes members representing the CLA, the Lakes Region Planning Commission, the New Hampshire Department of Environmental Services (NHDES), the New Hampshire Lakes Lay Monitoring Program, the Natural Resource Conservation Service (NRCS), the NH Department of Transportation (DOT), the Chocorua Lake Conservation Foundation, the Carroll County Conservation District, the Green Mountain Conservation Group and the Tamworth Selectmen. The Lakes Lay Monitoring Program (LLMP) will utilize its existing volunteer network to contribute to the proposed monitoring effort.

This project will be funded by a US EPA Clean Water Act, Section 319, grant through the New Hampshire Department of Environmental Services.

4.1 Project Organizational Chart

An organizational chart is provided below to depict the organization and responsibility structure of a typical project (Figure 1). An **advisory group** is usually employed to make recommendations for the project design, technical and analytical procedures and reporting requirements.

FIGURE 1 - Chocorua Watershed Project (Phase II) Organizational Chart



4.2 Communication Pathways

As the coordinator of the Chocorua Watershed Project Phase II Jeff Schloss will be the primary contact for all parties involved in the water quality monitoring effort. If problems arise in the field, laboratory, or in any phase of the study, Jeff Schloss will be contacted and will determine the best course of action based upon the circumstances and the outcome of a consultation with Robert Craycraft (Laboratory and Field Team Coordinator).

4.2.1 Modification to Approved QAPP

If the sampling design, sample collection procedures, or data assessment and reporting change significantly, the Project Manager will consult with the DES Program QA Coordinator to submit modification to EPA Region I.

4.3 Personnel Responsibilities and Qualifications

Table 2 displays the personnel duties and credentials.

Table 2. Personnel Responsibilities and Qualifications

Name and Affiliation	Responsibilities	Education and Experience Qualifications
Jeffrey Schloss UNH Cooperative Extension	Project Manager	B.S. Marine Zoology. B.A. Economics 1979, Duke University; M.S. Marine and Freshwater Biology 1985, The American University.
Robert Craycraft UNH Cooperative Extension	Field team and Laboratory supervisor Oversees laboratory QA/QC activities. Consults project manager for for necessary corrective actions.	B.S. Biology 1990, University of New Hampshire.
Richard Ellsemore Natural Resource Conservation Services	Provide reccomendations to mitigate water quality problems within the Chocorua Lake watershed.	B.A. Forestry 1986, University of Maine Orono
Chocorua Lake Association Volunteers	Collect Water Samples.	Trained by field team supervisor.
CFB Field Team Members	Collection of Stream, Lake, and Benthic Samples. Sample analysis and data transfers.	Trained by field team supervisor.

4.4 Special Training Requirements/Certification

Table 3 displays the project activities that require some level of training and the location where the training records will be compiled.

Table 3. Special Training Requirements/Certification

Project function	Description of Training	Training Provided by	Training Provided to	Location of Training Records
Water sampling	Water sample collection Procedures	Robert Craycraft	Chocorua Lake Association Volunteers	LLMP Laboratory
Stream Data Collection	Collecting Periphyton Samples	Robert Craycraft	CFB Field Team Members	LLMP Laboratory
Stream Data Collection	Measuring Streamflow	Robert Craycraft	CFB Field Team Members	LLMP Laboratory

5.0 Project Planning/Project Definition:

The Chocorua Watershed Project Phase II Quality Assurance Project Plan is a component of an ongoing water quality monitoring effort within the Chocorua Lake Watershed. This project is specifically designed to determine:

- The effectiveness of BMPs that were instituted adjacent to Rt. 16 within the past three years,
- The ability of interconnected wetland complexes at attenuating nutrients (specifically phosphorus and nitrogen) before reaching Chocorua Lake,
- Whether or not the Chocorua Lake water quality has improved since the implementation of the Rt. 16 BMPs.

5.1 Project Planning Meetings

The attendee names and organizations represented are summarized in Table 4.

1997-2000, Quarterly meetings were conducted to assess the progress of the Chocorua Lake Phase I project; BMPs were implemented adjacent to Chocorua Lake to attenuate the excessive nutrient and sediment load associated with Rt 16 runoff. These meetings included discussions of the BMP implementation timetable and the need for a more quantitative assessment of BMP effectiveness. During a summer project team planning meeting it was suggested that Jeff Schloss generate a water quality monitoring proposal to assess the effectiveness of the Rt 16 BMPs and other water quality threats within the Chocorua Lake watershed. See Table 4 for a listing of project team members present during these quarterly meetings.

December 1, 2000, a post-BMP water quality monitoring proposal was presented to the group and approved by the Chocorua Lake Project Team. Members Present: Eric Williams, Peter Pohl, Ken Kyle, Dwight Baldwin, Bob Craycraft, Joan Richardson, Rick Ellsmore and Rick DeMark.

May 10, 2001, provided a status report of the Chocorua Lake water quality sampling program. Eric Williams, Peter Pohl, Ken Kyle, Dwight Baldwin, Bob Craycraft, Joan Richardson, Rick Ellsmore and Rick DeMark.

Table 4. Chocorua Lake Project Team Members

Name	Organization Represented
Robert Craycraft	University of New Hampshire Cooperative Extension
Ken Kyle	NH Department of Transportation
Mark Morrill	NH Department of Transportation
David Little	Chocorua Lake Foundation
Neeley Lanou	Chocorua Lake Foundation
Jeffrey Schloss	UNHCE and UNH Center for Freshwater Biology
Joan Richardson	Natural Resource Conservation Service
Rick Ellesmore	Natural Resource Conservation Service
Dwight Baldwin	Chocorua Lake Association
Toby Page	Chocorua Lake Assoication
John Roberts	Tamworth Selectman
Rick Demark	North Country Resource and Conservation District
Eric Williams	NH Department of Environmental Services
Peter Pohl	Carrol County Cooperative Extension
Brianne Fellows	Americorp Member
Blair Folts	Green Mountain Conservation Group

July 19, 2001, an update of water quality monitoring efforts and preliminary findings was presented to the Chocorua Lake Project Team.

October 18, 2001, provided an update of the Chocorua Lake water quality monitoring effort to the Chocorua Lake Project Team. Members Present: Dwight Baldwin, Rick Ellsmore, Joan Richardson, Bob Craycraft, Jeff Schloss, Blair Folts, Eric Williams, Brianne Fellows, Rick DeMark.

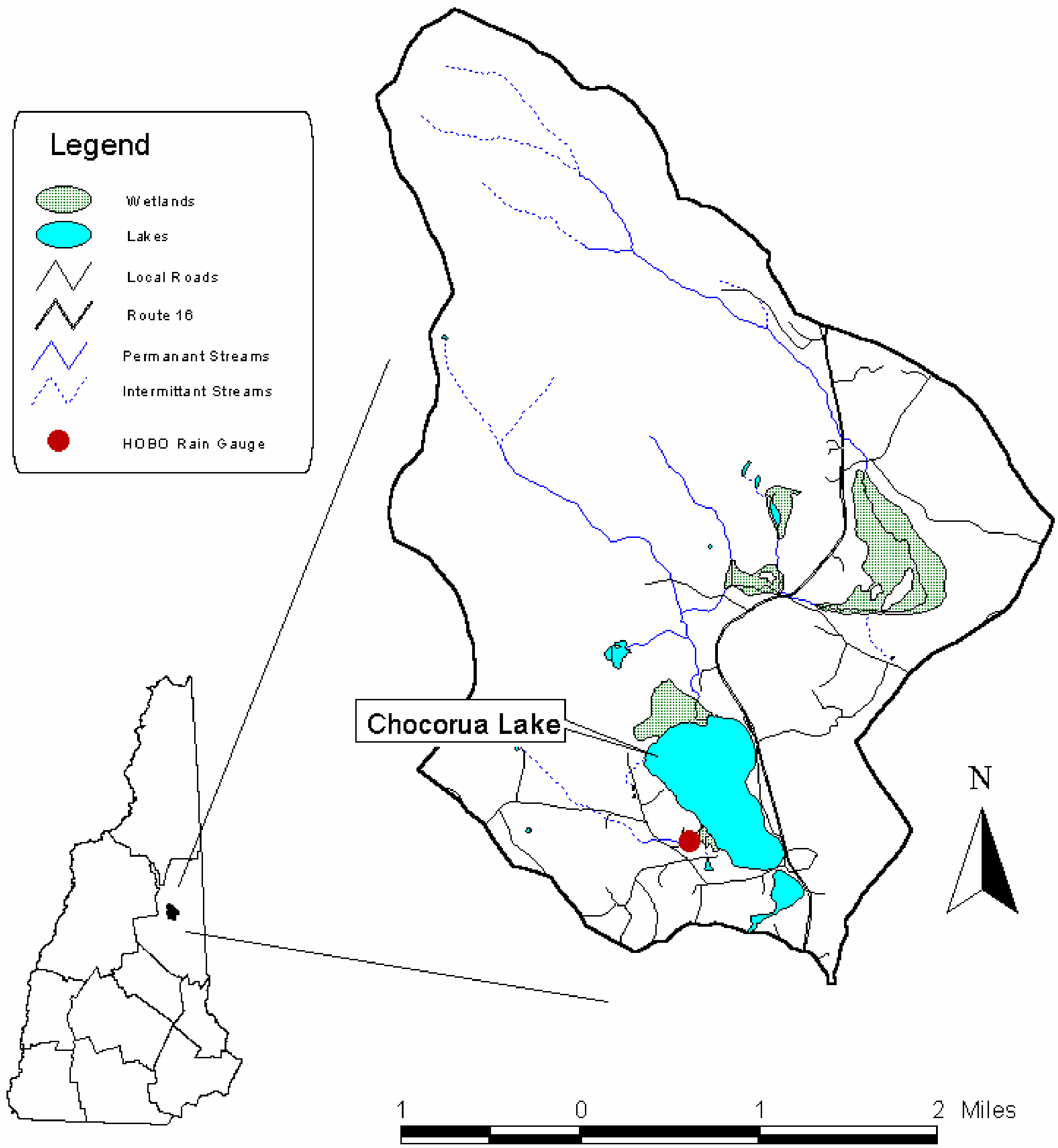
January 10, 2002, provided a review of preliminary Chocorua Lake periphyton system results to the Chocorua Lake Project Team. Spring 2002 water quality monitoring plans were also discussed and included continued wetlands monitoring along the Chocorua River, Continued monitoring of berms, swales and rip-rap between Rt 16 and Chocorua Lake, and initiate lake sediment coring in the spring. Members Present: Dwight Baldwin, Rick Ellsmore, Joan Richardson, Bob Craycraft, David Little, Peter Pohl, Brianne Fellows and Rick DeMark.

January 30, 2003, provided a status report of BMP maintenance activities as documented in an MOU between the DOT and the CLA. The meeting also involved a discussion of the benthic sediment coring (proposed in draft 3 of the CWPP) and it was decided that this component of the post-bmp monitoring would be removed from the CWPP and subsequently submitted through a separate NPS grant at a later date. Members Present: Dwight Baldwin, Mark Morrill, Jeff Schloss, Peter Pohl, Joan Richardson, David Little and Rick DeMark.

5.2 Problem Definition/Site History and Background

Phase II of the Chocorua Watershed Project focuses on the Chocorua Lake Watershed (Figure 2), Tamworth, New Hampshire where ongoing remediation efforts are directed at reducing Non Point Source (NPS) pollution impacts on Chocorua Lake. A watershed nutrient/water budget (conducted 1996-1997; reported: Schloss 2000), conducted by the University of New Hampshire Center for Freshwater Biology, indicated a disproportionate concentration of phosphorus entered Chocorua Lake from the Route 16 subwatershed; the Route 16 subwatershed constituted only 5% of the Chocorua watershed flow but accounted for 15% of the annual phosphorus load. On an areal basis (per unit area) the Route 16 subwatershed had more than 3 times the loading than the western drainage (largest land area) and over 2 times the loading of the eastern drainage. The construction of berms and swales, as well as, riparian plantings have been completed between the northeastern segment of Chocorua Lake and Route 16 that runs adjacent to the lake.

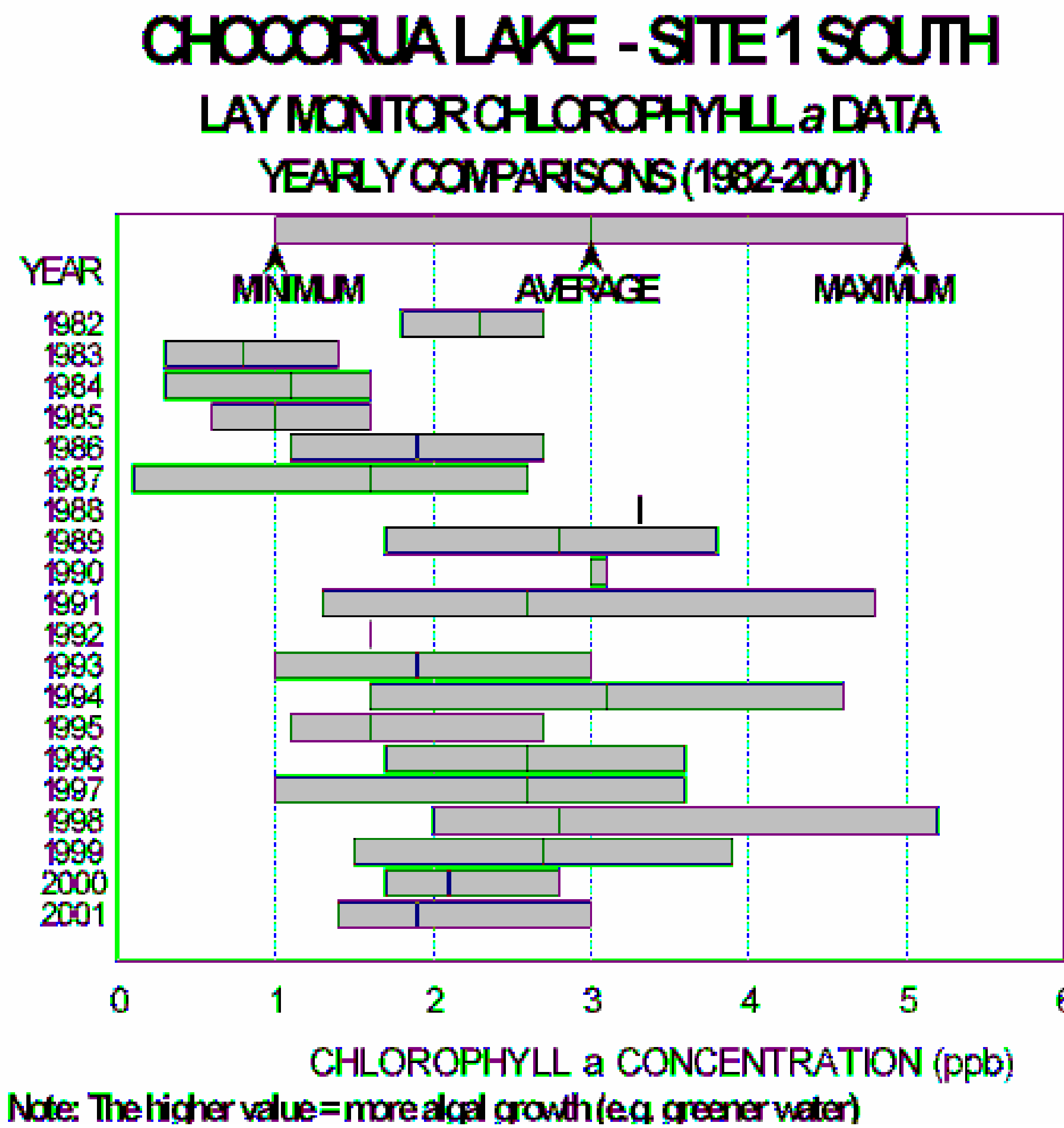
Figure 2. Chocorua Lake Watershed Carroll County, Tamworth New Hampshire



Chocorua Lake, Tamworth New Hampshire, is located in the Ossipee Lake watershed that contains New Hampshire's largest stratified drift aquifer. The Chocorua Lake watershed is predominantly forested, with riparian cover along the northern, western and southern sections of Chocorua Lake. The Rt. 16 travel corridor, a major transport route to the White Mountains National Forest and numerous ski areas, runs adjacent to the eastern section of Chocorua Lake. The Rt. 16 travel corridor is characterized by a significant reduction in riparian vegetation to the east and has been identified as a major source of NPS pollution that enters Chocorua Lake (Schloss, 2000).

Water quality data collected between 1982 and 2001 exhibit a general increase in algal growth over the 18 year span (Figure 3). The increase in algal growth, through 1995, culminated in heightened awareness of potential water quality problems. This heightened awareness prompted an in-depth water/nutrient budget of the Chocorua Lake watershed that was conducted between May 1996 and July 1997 by the LLMP in conjunction with CLA. The Chocorua Lake water/nutrient budget entailed the collection of weekly stream discharge and total phosphorus samples from the

Figure 3. Chocorua Lake: Annual chlorophyll *a* trends.



permanent stream inlets and the Chocorua Lake Outlet. A series of intermittent stream culverts, adjacent to Rt. 16, were also sampled during the period of spring thaw and during/following heavy storm events (Figures 4 and 5). The study results indicated that a disproportionate amount of phosphorus loading occurred in the Rt 16 subwatershed (on a per unit area basis); the Rt 16 drainage contributed more than twice the phosphorus load of the Chocorua River and over three times the phosphorus load of the western drainage (Figure 6).

Water quality data collected by the CLA and LLMP clearly indicated NPS pollutant inputs were having an adverse affect on Chocorua Lake. The Chocorua Lake Project Team formed in 1997, with the goal of identifying and mitigating water quality problems within the watershed. Following numerous meetings and a period of consensus building, several erosion problems along Rt 16 were prioritized and Phase I grant monies were obtained to institute BMPs that included culvert modifications, the construction of berms, swales and the lining of culverts with rip-rap. Phase II of this project was developed to answer four primary questions:

- What is the effectiveness of BMPs, installed adjacent to Rt. 16, at attenuating nutrients and total suspended solids in a series of drainage culverts adjacent to Rt 16?
- What is the effectiveness of a series of wetland complexes along the Chocorua River at attenuating phosphorus prior to reaching the Chocorua Lake? Can this phosphorus attenuation be detected through the use of periphyton monitoring?
- Has the Chocorua Lake water quality improved since the implementation of the Rt. 16 BMPS?

The Rt 16 BMP effectiveness will be assessed through a series of upstream/downstream sampling sites to discern the changes in total suspended solids, total phosphorus, total nitrogen, specific conductivity, temperature and turbidity as water flows through the BMP treatment areas. The BMP effectiveness study will also consist of a series of paired watersheds that will be used to evaluate the effectiveness of the BMPs relative to locations where no BMPs have been implemented. Measured parameters will include soluble reactive phosphorus, total phosphorus, total nitrogen, total suspended solids, specific conductivity, temperature, turbidity and stream discharge.

The Chocorua Lake water/phosphorus budget demonstrated that a series of wetland complexes along the northern, Chocorua River, tributary inlet serve to attenuate nutrients before reaching Chocorua Lake. These natural detention basins provide the vital function of purifying the water and minimizing the impacts of future land use change, thus minimizing the rate of eutrophication. Data generated through this study are intended to highlight the importance of these natural detention basins in hopes that future land management techniques will protect these valuable resources.

The Chocorua River sampling regime will also include a series of upstream/downstream artificial periphyton substrates that integrate the long-term nutrient load into Chocorua Lake and will be used to assess how well the wetland complexes attenuate nutrients. These periphyton samplers will serve as surrogates for the nutrient loading that occurs between the spring and fall months since our resources will not facilitate the deployment of nutrient autosamplers nor the analysis of arguably thousands of nutrient samples that would be required to determine the nutrient attenuation as water passes through the series of wetlands. However, we do propose the collection of concurrent soluble reactive phosphorus, total phosphorus, total nitrogen, turbidity and temperature measurements to add to our baseline physio/chemical data.

Figure 4. Route 16 Post BMP Culvert Monitoring (North)

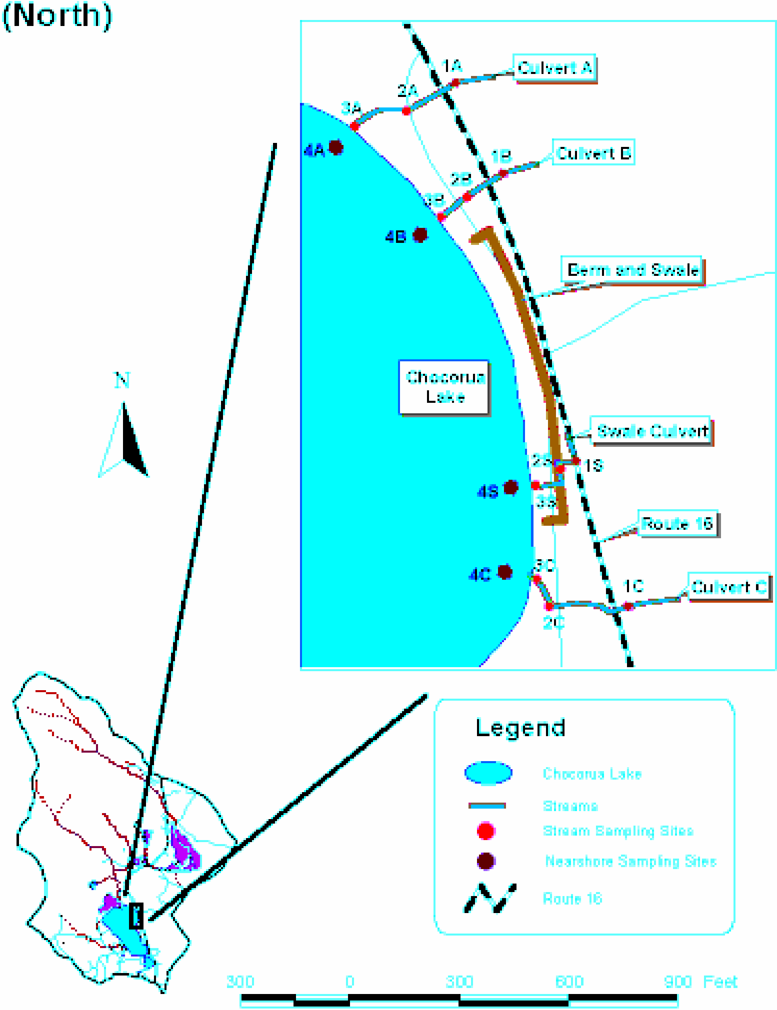
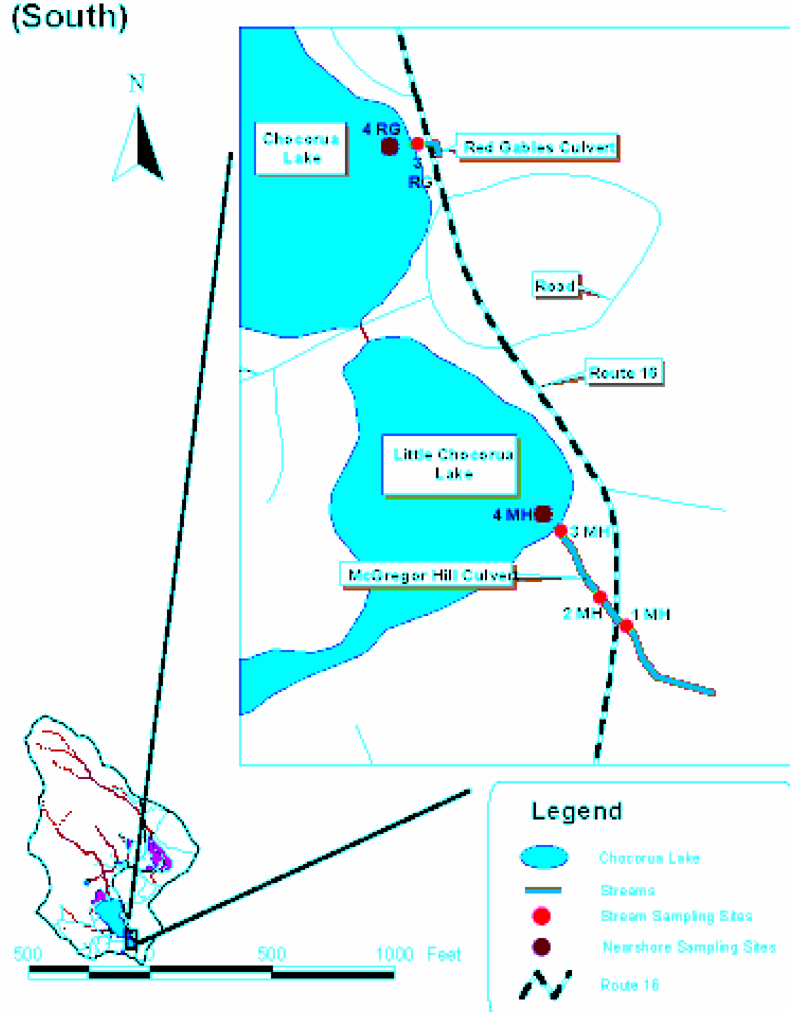
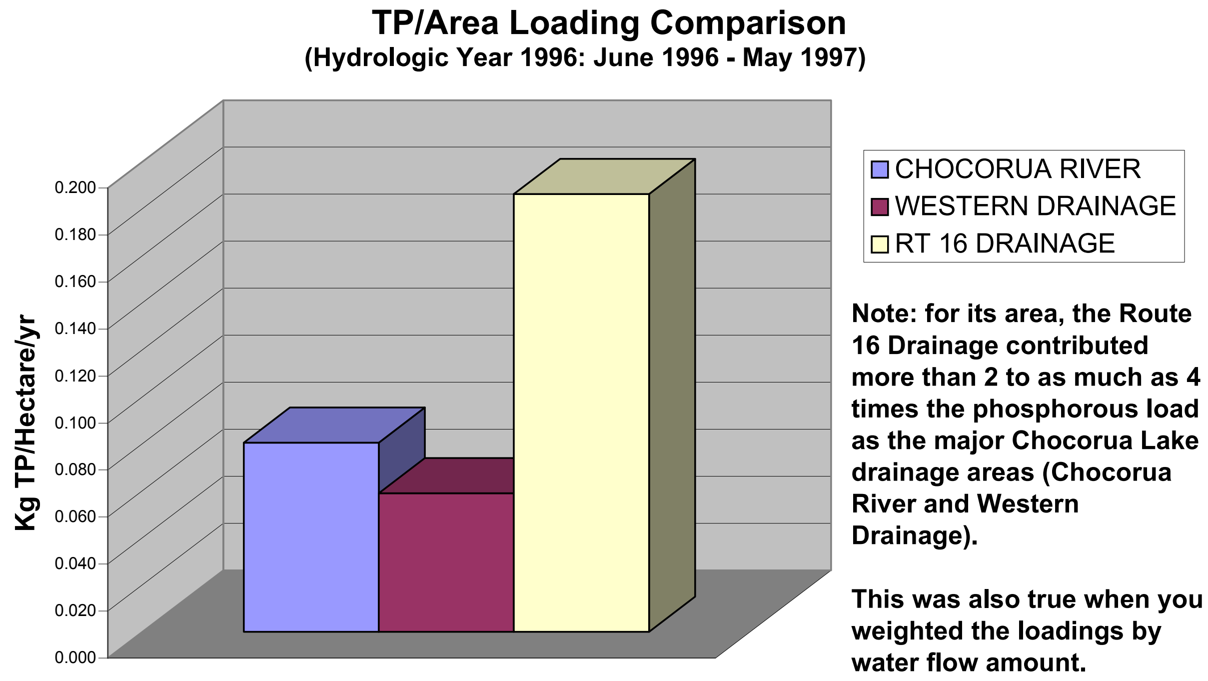


Figure 5. Route 16 Post BMP Culvert Monitoring (South)



In-lake total phosphorus and Secchi Disk transparency data will be collected at a deep centrally located sampling location, a sampling location at the mouth of the Chocorua River and a sampling location at the Dam outlet to assess the lake response to nutrient loading. The LLMP has a long-term record of Secchi Disk transparency and total phosphorus data dating back to 1982 that will be used to assess the Lake's response to the implemented BMPs.

Figure 6. Chocorua Lake Phosphorus Loading per unit area



6.0 Project Description and Schedule

6.1 Project Overview

The Chocorua Watershed Project Phase II is designed to complete a series of objectives that have been identified at previous Chocorua Lake Project Team meetings as follows:

1) To document the success of our collaboration as exemplified in the effectiveness of the implemented BMPs adjacent to Route 16.
2) To provide information that could be used/transferred to benefit non-point source pollution reduction efforts throughout the state and region.
3) To evaluate the impacts/benefits of the wetland complexes and peripheral wetlands in the watershed.
4) To attempt to mitigate existing threats and minimize additional threats to the water quality in the watershed.
5) To better understand and define future threats within the Chocorua Watershed.

While these objectives represent separate efforts per se, they all are related to, and compliment, each other in providing a greater understanding of the watershed system as a management unit. While beyond the scope of this project, the objectives outlined above will ultimately facilitate the development of a Lake Diagnostic Model that would allow us to predict the lake response to phosphorus loading decreases and increases.

The Chocorua Watershed Project Phase II objectives will be accomplished by implementing four sampling tasks:

<u>6.1.1 Task I- Post BMP Installation Monitoring/Evaluation of the Route 16 Culverts.</u>

<u>Rationale:</u> At the core of the CWPP QAPP is the need to continue the follow-up, post-BMP monitoring that will document the effectiveness of the management practices put in place to reduce the sediment and phosphorus load into Chocorua Lake. We have set up a series of sampling stations in each culvert that will track the nitrogen, phosphorus and TSS levels as the water flows from a forested site, through an impacted stretch of the culvert and into Chocorua Lake (Figures 4 and 5). The sampling design allows us to follow storm flow through the BMP treatment areas to see what pollutant reductions take place.

<u>Sampling Tasks:</u> Physical and Chemical water quality samples and measurements will be collected during, or immediately following heavy storm events, when the sediment and nutrient loading tends to be most severe. An attempt will be made to collect the water sample during the most intense period of each storm event.

<u>Analysis Tasks:</u> Temperature and Specific Conductivity measurements will be measured in-situ throughout the monitoring period while water samples will be collected and analyzed in the laboratory for nutrients and total suspended solids. Discharge measurements will be calculated based on the stream channel dimensions and the concurrent streamflow measurements that are collected in each of the six culverts during each sampling event. Discharge calculations will be based on standard hydrological calculations (width * depth * velocity). Laboratory analyses will be performed in the CFB laboratory and will include Total Phosphorus (TP) analysis, through

persulfate digestion, Total Nitrogen (TN), through second derivative spectroscopy, Total Suspended Solids (TSS) and Turbidity.

6.1.2 Task II - Deep Lake and Major Tributary Sampling.

Rationale: Post-BMP total phosphorus and Secchi Disk data will be collected in Chocorua Lake and will be compared to the Pre-BMP phosphorus and Secchi Disk transparency data to determine whether or not the in-lake phosphorus concentrations have improved (i.e. lower values) since the BMPs were implemented in 1999.

Sampling Tasks: Bi-weekly water quality samples will be collected at three sampling locations in Chocorua Lake to track the seasonal phosphorus concentrations at the major tributary inlet (Site 1P), at a centrally located deep reference location (Site 2P) and near the Chocorua Lake outlet (Site 3P) as depicted in Figure 7. Supplemental Secchi Disk transparency measurements will be limited to the deep centrally located sampling station (Site 2P) to discern the seasonal Secchi Disk transparency trends and to determine the seasonal average water transparency. The Task II water quality data will be collected following the period of ice-out and continue through the period of fall overturn that typically occurs in mid-September at the Chocorua Lake deep reference location.

Analysis Tasks: Secchi Disk transparency measurements will be collected by the CLA volunteers at the deep Chocorua Lake sampling location (Site 2P) on each sampling date. No Secchi Disk transparency data will be collected at the tributary inlet or the lake outlet due to the shallowness of the sites. TP data will be collected by the CLA volunteers at each of the three sampling stations during the entire study period.

6.1.3 Task III- Integrated Nutrient Sampling of Pre and Post Wetland Impacts.

Rationale: A series of periphyton (attached algae) samplers will serve to assess the effectiveness of a series of natural wetlands at attenuating nutrients before reaching Chocorua Lake. Samples collected upstream and downstream of a series of wetland complexes located along the Chocorua River, as well as, samples collected in Chocorua Lake will serve to track changes in the nutrient loading among sampling locations (Figure 8). The periphyton samples will integrate the nutrient load over relatively long (i.e. two week) time periods and will reflect short-term nutrient inputs that might be missed during a more traditional nutrient sampling study during which discrete (i.e. weekly/bi-weekly) samples are collected. Soluble reactive phosphorus (SRP) samples, absent from Tasks I & II, will be included in Task III to best assess the amount of phosphorus available to promote periphyton growth. Considering the Chocorua River is a lotic system, it is important to collect the SRP samples that will best reflect the phosphorus available for periphyton growth at the various sampling sites. Total phosphorus samples will also be collected at the Task III sampling sites since the phosphorus will ultimately be deposited into lentic systems, wetland complexes and ultimately Chocorua Lake, where the total phosphorus will become available to photosynthetic organisms through chemical conversions associated with the phosphorus cycle. The relationship between TP and in-lake phytoplankton growth has been well established in the scientific literature.

Sampling Tasks: Physical and Chemical and Biological water quality samples and measurements will be collected during each sampling event. Light, temperature and humidity data will be downloaded from the HOBO field meters during each sampling trip. We tentatively intend to collect the Task III data on a bi-weekly basis although the actual sampling interval might longer if the periphyton growth is deemed insufficient when using a bi-weekly sampling frequency.

Analysis Tasks: Temperature and Specific Conductivity measurements will be measured in-situ throughout the monitoring period while water samples will be collected and analyzed in the laboratory for nutrients and total suspended solids. Discharge measurements will be calculated based on the stream channel dimensions and the concurrent streamflow measurements that are collected in each of the six culverts during each sampling event. Discharge calculations will be based on standard hydrological calculations (width * depth * velocity). Laboratory analyses will be performed in the CFB laboratory and will include TP analysis, Soluble Reactive Phosphorus (SRP) analysis, TN analysis, Turbidity analysis and chlorophyll *a* via spectrophotometric analysis.

Figure 7. In-Lake and Major Tributary Sampling Sites.

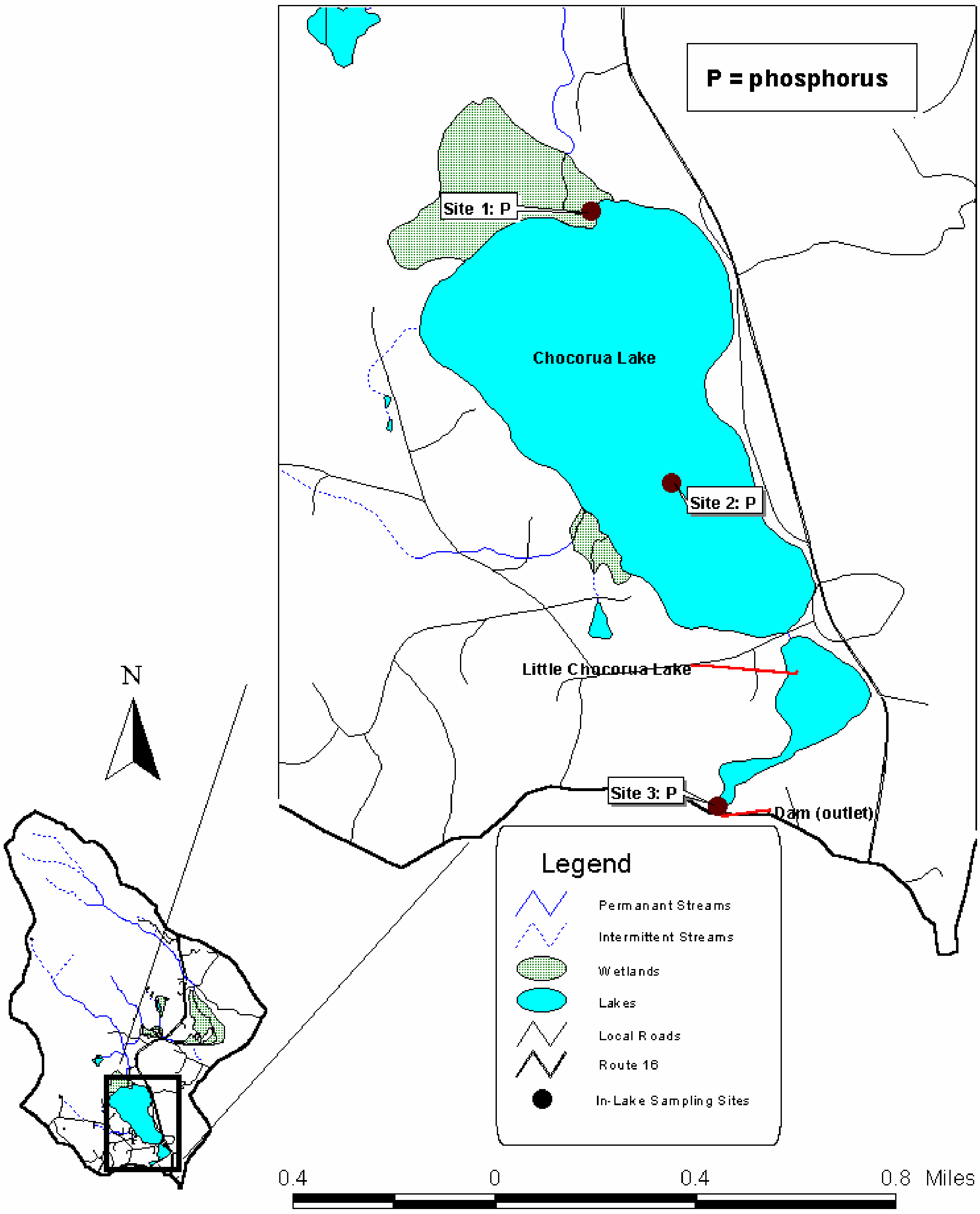
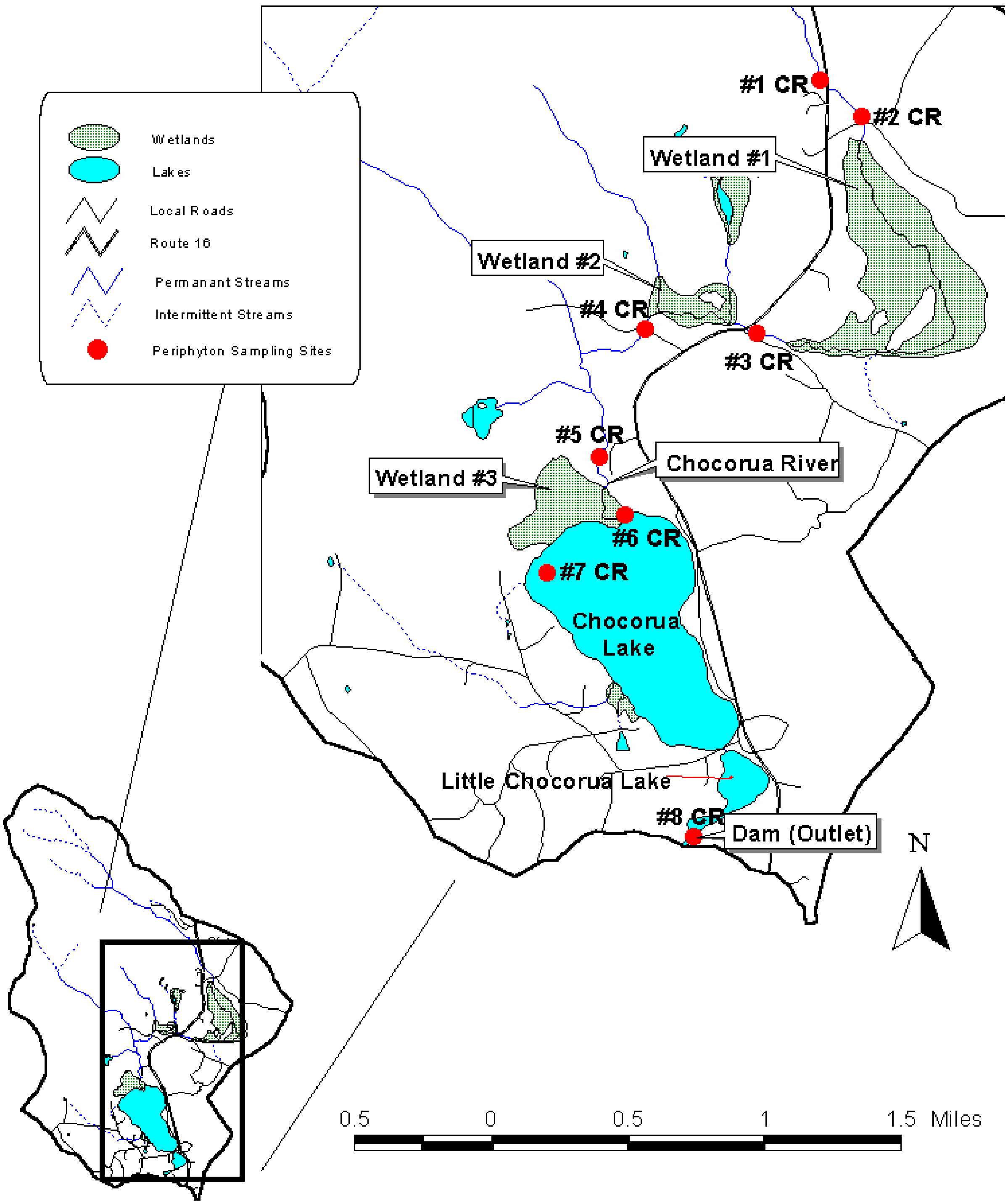


Figure 8. Periphyton Sampling Locations



6.1.4 Quality control tasks

Field water quality instrumentation and laboratory analytical instrumentation are calibrated according to manufacturer's specifications prior to all field measurements and laboratory analysis. Sample bottles are appropriately prepared (e.g. acid washed, rinsed) prior to sample collection. Duplicate samples are collected and analyzed at a frequency of 5% or one per field sampling trip, whichever is more frequent. Periodic meetings among the Project Coordinator, QA Officer/laboratory coordinator, the laboratory technicians and the field team technicians will assure project objectives are being meet and problems are promptly remedied.

6.1.5 Secondary data

Supplemental water quality data collected through the New Hampshire Lakes Lay Monitoring Program might serve as secondary data for the CWPP. Supplemental data could include in-lake chlorophyll *a* data and weekly Secchi Disk transparency measurements that reflect Chocorua Lake's response to nutrient loading.

6.1.6 Data management tasks

Field data are recorded on field data sheets while laboratory data are recorded in laboratory notebooks. All data sheets are returned to the CFB laboratory and retained in three ring binders. Add data will be entered onto Microsoft access database files to facilitate quick data access for subsequent tasks (i.e. data summaries, graphic analysis). All digitized data will be printed and checked against the field datasheets and the laboratory notebooks to assure data accuracy.

6.1.7 Documentation and records

Field data sheets will be used during each sampling trip throughout the data collection period. A. field data and field comments will be recorded on the appropriate field datasheets.

6.1.8 Data packages

All data collected through this project will be compiled into a summary report due at completion of the CWPP and submitted to the DES and the Chocorua Lake advisory group. Summary data tables and/or summary reports might also be distributed local decision makers, lake, land and watershed associations, agency staff, advisory boards, educators and their students, researchers, conservation organizations, service groups, private consultants and interested citizens.

6.1.9 Data verification and validation tasks

Data are verified by referencing replicate samples, reviewing critical ranges, reviewing the consistancy of spiked samples and reviewing duplicate samples. The data are screened for outliers and any outliers are highlighted and examined to determine the deviation source. Data are also compared with existing and historical data from individual sampling locations.

6.1.10 Data usability tasks

Data usability is directly related to verification and validation. Only valid data will be used in the CWPP as summarized in Section 20.

6.2 Project Schedule

Table 5 outlines the schedule of work to be completed as part of this project. In the case of delays, Jeffrey Schloss, Project Manager will be notified. Jeff Schloss will consult Bob Craycraft, QA Coordinator, who will adjust the schedule and will notify other parties who are affected by the delay. The sample collection will continue through the fall and is expected to be completed by December 1, 2003. The grant contract expires on December 31, 2003.

Table 5. Project Schedule Timeline

Activity	Dates (MM/DD/YYYY)		Deliverable	Due Date
QAPP Preparation	12/1/01	4/1/03	QAPP document	4/1/03
Sample Collection:				
Task I	Upon approval	11/20/03	Water Samples	11/20/03
Task II	Upon approval	10/1/03	Water Samples	10/15/03
Task III	5/1/03	9/31/03	Water Samples	9/31/03
Laboratory analyses:				
Task I	Upon approval	11/10/03	Lab Reports	12/1/03
Task II	Upon approval	11/10/03	Lab Reports	11/15/03
Task III	5/1/03	10/15/03	Lab Reports	10/31/03
Data validation	Upon approval	12/1/03	Raw Data	Ongoing as analyzed
Data assessment report	12/1/02	12/31/03	Documentation	
Final project report preparation	11/15/03	12/31/03	Final Project Report	12/31/03

7.0 Project Quality Objectives and Measurement Performance Criteria

7.1 Project Quality Objectives

The data generated through this study will be used primarily to determine the effectiveness of BMPs along Rt 16 to determine the ability of wetlands to attenuate nutrients, and to discern trends and locate actual or potential NPS pollution threats within the watershed. In addition, the data will assist in the development of watershed protection recommendations. No direct enforcement or legal actions are planned to be taken from any of the sampling. If any suspect conditions or violations are indicated by the CFB data, we will alert the health officers of the towns and the New Hampshire Department of Environmental Services Water Division (the proper authorities for code enforcement and legal actions).

Data will be collected using consistent sampling protocols and the laboratory samples will include a minimum of 10% replicate and 10% blank samples. Nutrient concentrations documented by previous CFB studies indicate low baseline phosphorus concentrations (<5 ug/L) in our reference sampling locations. To maximize the reliability of our nutrient data, 100% of TP, TN and soluble reactive phosphate samples will be replicated.

7.2 Measurement Performance Criteria

Precision is the degree of agreement between/among repeated measurements that are collected simultaneously at the same field sampling location. For the purpose of this study will be assessed as the relative percent difference (RPD) between replicate samples using the equation:

$$RPD = \frac{(x_1 - x_2)}{(x_1 + x_2)/2} \times 100$$

At least one field replicate will be collected during each sampling event and a minimum of 5% of the field samples will be collected in replicate. When multiple field sampling teams collect

Table 6. Measurement Performance Criteria For Surface Water Samples in a water matrix.

Parameter	Meas. Range	Precision (field)	Accuracy	Reporting Limit
Total Phosphorus	3.0 - 200.0 *u*g/L	+/- 15%	90 - 110%	2 *u*g/L
Soluble Reactive Phos.	2.0 - 30.0 *u*g/L	+/- 1 ug/L; +/- 10%[1]	90 - 110%	1 *u*g/L
Total Nitrogen	100 - 1000 *u*g/L	+/- 15%	90 - 110%	100 *u*g/L
Turbidity	0.2 - 100.0 NTU	+/- 15%	-----	0.20 NTU
Temperature	0.0 - 30.0^{o}C	+/- 0.2 ^{o}C	-----	0.1^{o}C
Specific Conductivity	10.0 - 2000 *u*S/cm	+/- 5%	-----	10 *u*S/cm
Total Suspended Solids	2.0 - 100.0 mg/L	+/- 15%	-----	2.0 mg/L
Chlorophyll *a*	0.5 - 10.0 mg/m^2	+/- 20%	-----	0.2 mg/m^2 [1]

[1] Precision will be +/- 1 *u*g/L for SRP values below 10 *u*g/L and +/- 10% for SRP values at or above 10 *u*g/L.

samples during a field visit each team will collect at least one field replicate. The desired field precision data are reported in table 6 while the RPD of laboratory replicates will be set at 10% for the TP and SRP samples. Laboratory precision for TN samples will be set at 15% for concentrations below 500 *u*g/L and at 10% for concentrations at or above 500 *u*g/L.

Accuracy/Bias is an indicator of measurement confidence. Accuracy will be measured by the analysis of spiked laboratory samples. A sample is divided into two portions (aliquots). A known amount of standard is added "spiked" to one aliquot. Both aliquots are then analyzed and the amount of the spiked material recovered is compared to the amount added using the following equation:

$$\%\ Accuracy/Bias = \frac{SpikedSampleConc. - UnspikedSampleConc.}{Spiked\ Conc.\ Added} \times 100$$

Spiked TP, TN and SRP samples will be analyzed at a frequency of 5% or one per analytical batch, whichever is more frequent.

Quantitation Limits (Reporting Limits) – The quantitation limit is the lowest value which a laboratory can quantitatively report with confidence. The analytical method, analytical/achievable method detection limit, and the analytical/achievable laboratory quantitation limits for this project are summarized in Table 7.

Representativeness is a qualitative term that describes the extend to which a sampling design adequately reflects the environmental conditions of a site. Sampling locations outlined in this study were chosen that would best reflect the nutrient and sediment loading into Chocorua Lake and that would also serve to assess the effectiveness of the implemented BMPs around the lake and to monitor nutrient attenuation function of the surrounding wetlands. Site locations and rationale were previously discussed under the site and methodological summaries.

Comparability among samples will be achieved by maintaining consistency with SOPs, sampling locations and sampling methods. Samples will be collected at the same, specified, locations throughout the study and all samples will be processed within the specified holding times. Many of the current sampling locations correspond to historical sampling locations that will allow data comparisons between the data collected during this study and the historical data collected by the University of New Hampshire Lakes Lay Monitoring Program.

Completeness. The completeness of the database is a critical aspect of data quality and data

Table 7. Surface Water Target Analytes and Detection Limits

Analyte	Analytical method (See Appendix A for SOP Reference	Analytical/Achievable Method Detection Limit	Analytical/Achievable Laboratory Quantitation Limit
Total Phosphorus	Std. Meth. 4500-P E.	0.78 ug/L	2.0 ug/L
Soluble Reactive Phosphorus	Std. Meth. 4500-P.E.	0.27 ug/L	1.0 ug/L
Total Nitrogen	* Primary literature	35.8 ug/L	100 ug/L
Total Suspended Solids	Std. Meth. 2540 D.	0.3 mg/L	2 mg/L
Temperature	Std. Meth. 2550 B.	-----	-----
Conductivity	Std. Meth. 2510 B.	0.5 uS	10 uS
Turbidity	USEPA 180.1	0.05 NTU	0.20 NTU
Chlorophyll	Std. Meth. 10200 H.2	0.1 mg/m^2	0.2 mg/m^2

*Total Nitrogen Analyses via second derivative spectroscopy are based on the methods described by Bachman and Canfield (1996) and by Crumpton, W.G (1992). The second derivative spectroscopy method is currently under review and should appear in the 21st edition of Standard Methods. Refer to appendix E for copies of the primary journal articles.

usefulness. These data will be used to assess the effectiveness of implemented BMPs and the ability of wetland complexes to attenuate nutrients. The study will attempt to characterize a minimum of three intense storm events (> .75 inches) as well as up to seven additional storm events. However, given the inherent difficulty of collecting water samples at specific points during a storm event, there will likely be storms for which incomplete data are collected. The intermittent nature of the streams might also result in the collection of only partial data during a given storm event.

8.0 Sampling Process Design (Experimental Design)

8.1 Sampling Design Rationale

Four sampling tasks are required for this project that will collectively increase our understanding of nutrient loading and potential threats within the Chocorua Lake watershed. Each of the four tasks are described below and include specific rationale for the respective tasks while the collective data will ultimately be used in future water quality modeling of Chocorua Lake.

Table 8. Sampling Task I Field Sampling Summary.

Analyte	Total no. of sampling locations	No. of samples per runoff event per site	Number of runoff events sampled	Number of field duplicates	Number of bottle blanks	Total number of samples to lab
Total Phosphorus	22	1	10	1/runoff event = 10	1/runoff event = 10	240
Total Nitrogen	22	1	10	1/runoff event = 10	1/runoff event = 10	240
Total Suspended Solids	22	1	10	1/runoff event = 10	1/runoff event = 10	240
Turbidity	22	1	10	1/runoff event = 10	1/runoff event = 10	240
Conductivity	22	1	10	1 re-measurement/ sampling location	NA	measured *in situ*
Temperature	22	1	10	1 re-measurement/ sampling location	NA	measured *in situ*
Streamflow	6	1	10	1 re-measurment/	NA	measured *in situ*

8.1.1 Sampling Task I- Post BMP Installation Monitoring/Evaluation of the Route 16 Culverts

A nested watershed design, a.k.a. an “above-and-below” design will be used to evaluate the effectiveness of BMPs that have been designed and implemented along Route 16. These sites represent those areas that have BMPs in place and areas that remained unchanged to serve as “controls”. During a pre-conference workshop at the 14th Annual Enhancing the States’ Lake Management Programs, Davenport et. al. (April 17, 2001) suggested pre/post watershed studies should optimally include both an upstream/downstream and paired watershed component to the study. The proposed CWPP will employ such an approach to best assess the impact of the BMPs by monitoring upstream/downstream of the berms, swales, rip-rap and plunge pools. Paired watersheds will then control for the effects of hydrologic variation and account for the natural water quality variations. We intend to collect runoff samples on as many as 10 sampling dates but on no fewer than 5 sampling dates. These are intermittent culverts and thus the number of days sampled will be dependent upon the year's weather patterns. Sample collection will occur during and immediately following periods of heavy precipitation. We also have historical, pre-BMP data, that will further assess the effectiveness of the implemented BMPs. TP, TN TSS, Turbidity, Conductivity and Temperature data will be collected at all 22 sampling locations as indicated in Table 8.

Six culverts will be sampled at multiple points, during or immediately following storm events, to assess the effectiveness of the implemented BMPs to attenuate pollutants before the contaminants enter Chocorua Lake. The storm sampling will be limited to precipitation events during which the rainfall totals a minimum of ½ inch over a 24 hour period while at least two of the storm sampling events be conducted during storm events characterized by ¾ inches of rainfall, considered the threshold for significant overland runoff (Hewlett, 1982), over a 24 hour period. A minimum antecedent dry period of 72 hours will be required between any two successive storm sampling events. Storm event sampling will focus on the spring period of spring melt when the ground is saturated and minimal vegetative cover is available to intercept water and particulate debris. Likewise, emphasis will be placed on storm event sampling that is conducted during wet summer and fall periods where heavy periods of rainfall over the past several days/week have raised the groundwater table and will translate into increased stream-flow. Additional storm event sampling will be conducted during the drier summer months that are generally characterized by a lower water table and reduced groundwater recharge that coincide with increased evapotranspiration rates. Storm events during the dry summer months will be characterized by an increase in the relative contribution of the Rt 16 sheet runoff and will provide some insight into the BMPs' abilities to slow the water flow and attenuate particulate debris when the vegetative cover comes into bloom.

The CFB field team will prepare the appropriate sampling equipment and sampling bottles when large storm fronts have been identified and are predicted for the Town of Tamworth, NH. The storm event sampling will be conducted when the rainfall culminates into overland, channelized, flow in our Task I study culverts. Since sediment runoff was previously identified as the primary means of phosphorus loading along the Rt 16 corridor (Schloss, 2000), our criteria for culvert sampling will be based on the presence of surface flow as opposed to some absolute antecedent rainfall threshold. Intense (i.e. downpours) storm events will be selected over other less intense storm events. Focus will also be placed on long-duration storm events that will saturate the soil and increase the amount of surface water flow.

Ambient precipitation data will be collected within the Chocorua Lake watershed (Figure 3) using a HOBO (model RG2) data logging rain gauge that records ambient rainfall in .01 inch increments. Precipitation data collected at the National Oceanic and Atmospheric Administration, Tamworth 4, climatological sampling station will also be reviewed following the respective storm events to determine whether or not the rainfall exceeded the ½ inch and ¾ inch thresholds. The CFB field team will attempt to collect the water quality data during the period of peak precipitation although data collected anytime during or immediately following the storm event, when the culverts are running, will be deemed acceptable.

The site nomenclature used in this study will consist of the culvert names followed by a numerical value between 1 and 4 as indicated in Table 9 and Figures 4 and 5 (note: the Red Gables culvert only consists of a lower site (#3) and an in-lake site (#4) due to the diffuse runoff that does not become channeled until it reaches Chocorua Lake).

Table 9. Task I Sampling Sites within each culvert and sampling rationale.

Site #	Location	Rationale
1	Forested watershed - upstream of Rt 16	Reference site for the respective culvert
2	3 meters downstream of Rt 16	Impaired site that receives Rt 16 runoff
3	In-stream - immediately adjacent to Chocorua Lake	Track pollutant attenuation between sites 2 and 3
4	In-lake - 3 meters from culvert mouths	Monitor in-lake pollutant levels

Theoretically, we expect relatively pure water from the the forested sites (#1), a reduction in water quality at the sites located 3 meters downstream of Rt 16 (#2) and a subsequent increase in water quality at the site immediately adjacent to Chocorua Lake (#3) that reflects the pollutant attenuation associated with the implemented BMPs. The final in-lake sampling site located adjacent to each culvert (#4) will track the nearshore physiochemical variables outlined in table 12. We intend to collect samples on a maximum of 4 sampling dates although the ambient weather patters will ultimately dictate the actual number of sampling dates.

Streamflow measurements will be collected using a Global Flow FP101 digital water velocity meter at each sampling location during each sampling trip. Stream geometry measurements (water depth and stream width) will be collected concurrently with the velocity measurements to facilitate the calculation of water and nutrient loading values at the respective sampling locations. Streamflow measurements will be collected at cylindrical concrete pipes, that run under Rt 16, in each of our six study culverts. Due to irregularities in the stream channel morphology, the collection of streamflow measurements in the cylindrical pipes should most accurately reflect the water volume in the respective culverts.

Table 10. Sampling Task II Field Sampling Summary

Analyte	No. of sampling locations	No. of samples per sampling date per site	Number of sampling dates	Number of field duplicates	Number of blanks	Total number of samples to lab
Total Phosphorus	3	1	8	1/sample date = 8	1/sample date = 8	40
Secchi Disk Transparency	1	1	8	1/sample date = 3	NA	NA

8.1.2 Sampling Task II – Deep Lake and Major Tributary Sampling

Bi-weekly TP and Secchi Disk transparency data will be collected at the deepest point in Chocorua Lake between June 1 and September 30, 2003. These measurements will reflect the cumulative impact of nutrients and particulate loading on Chocorua Lake (Table 10). TP samples will also be collected at the major lake inlet (Chocorua River) and the lake outlet (@ the Dam) to estimate the nutrient flow-through. The bi-weekly sampling will be used to assess Chocorua Lake's response to nutrient loading and help assess the Chocorua Lake's trophic status. The water quality data collected at the deep sampling site will be compared to the annual water quality data that have been collected in Chocorua Lake since 1982; the comparison of current and historical water quality data will help discern the any water quality changes that have occurred since the implementation of the Rt 16 BMPs (i.e. has the water quality improved).

8.1.3 Sampling Task III- Integrated Nutrient Sampling of Pre and Post Wetland Impacts

The Chocorua Lake nutrient/water budget study (Schloss, 2000) disclosed the significant protective functions that the Chocorua River wetlands play. The fact that the Route 16 drainage area is one of the few contributing subwatersheds not buffered by wetlands implies that nutrient reductions from the well buffered Chocorua River will large and positive (i.e. nutrient attenuation) impacts on sediment and nutrient load into Chocorua Lake. In-lake periphyton (attached algae) sampler deployments at various points within Chocorua Lake will help determine the in-lake response to nutrient loading. Supplemental TP, TN, SRP, turbidity, temperature and specific conductivity data will be collected to assess any correlations between the periphyton data and ambient physical and chemical parameters. Relatively low nutrient levels correlated well to local nutrient runoff conditions and periphyton productivity as measured on artificial substrates deployed in Sebego Lake Maine (Ken Wagner, personal communication regarding similar study on Sebago Lake). The typical Sebago Lake TP concentrations, that measure between 3 and 5 micrograms per liter, are similar to the TP concentrations typically measured in Chocorua Lake. The periphyton sampler data along with SRP, TN and TP samples, taken on a bi-weekly basis, should allow for a better understanding of in-stream nutrient loss, wetland nutrient assimilation rates and in-lake nutrient response. The study results will also be helpful in future modeling efforts of both watershed loadings and lake response/diagnostics.

The latest version of the EPA Rapid Bioassessment Protocol for use in Streams and Wadeable Rivers (Barbour et al, 1999; http://www.epa.gov/owow/monitoring/rbp/) lists the advantages of using an artificial substrate:

- *Artificial substrates allow sample collection in locations that are typically difficult to sample effectively (e.g., bedrock, boulder, or shifting substrates; deep or high velocity water).*

- *As a "passive" sample collection device, artificial substrates permit standardized sampling by eliminating subjectivity in sample collection technique. Direct sampling of natural substrate requires similar effort and degree of efficiency for the collection of each sample. Use of artificial substrates requires standardization of setting and retrieval; however, colonization provides the actual sampling mechanism.*

- *Confounding effects of habitat differences are minimized by providing a standardized microhabitat. Microhabitat standardization may promote selectivity for specific organisms if the artificial substrate provides a different microhabitat than that naturally available at a site.*

- *Sampling variability is decreased due to a reduction in microhabitat patchiness, improving the potential for spatial and temporal similarity among samples.*

- *Sample collection using artificial substrates may require less skill and training than direct sampling of natural substrates.*

Disadvantages listed involve logistics (having to return to the deployments), danger of loss or disturbance due to vandalism, the substrate's ability to influence periphyton community structure (ie: attached forms over motile forms), and a compromise of the usefulness or applicability of the siltation index. The objectives and goals of this study require the collection of the artificial substrates every two weeks through the study period. These retrievals will only involve removing, and replacing, the growth tiles (described later) from which the periphyton samples will be collected. Thus, the artificial substrates will otherwise remain in the same positions for the duration of the study. The community structure sampled from the periphyton samplers will be similar and not include motile forms is actually a plus as it will allow us to better discover how well the procedure allows for stream reach nutrient response assessment. As a siltation index is not a parameter of concern for this part of the study, and more direct measures of siltation from the BMP evaluations will be measured by direct turbidity of pre- and post structure measurements, the last disadvantage is moot.

The proposed periphyton (attached algae) sampler deployment brackets a series of three wetland complexes located along the Chocorua River (Figure 8). Total phosphorus data collected during the Chocorua Lake water/phosphorus budget (Schloss, 2000) indicate the second wetland

Table 11. Sampling Task III: Sampling locations and Sampling Rationale.

Site #	Location	Sampling Rationale
CR1	Upstream of Rt 16 (100% forested)	Minimally impacted Chocorua River reference site. data from this site will be compared to all other sites located along the Chocorua River.
CR2	Upstream of 1st wetland complex with some scattered houses within 100 meters of the river.	Data collected at this site will be compared to the data collected at Site 3 to assess the differences between the pre and post wetland water quality data.
CR3	Immediately downstream of the 1st wetland complex with some scattered houses within 100 meters of the river. This site is located about 100 meters upstream of the second Chocorua River wetland complex.	Data collected at this site will be compared to the Site 2 data discussed above. This site will also serve as the upstream sampling site for the second Chocorua River wetland complex.
CR4	Immediately downstream of the second wetland complex. This site There is a single house and a dirt road within 100 meters of this site. This is a relatively pristine site and the impact of the nearby road and house are considered negligible.	Data collected at this site will be compared to the Site 3 data to assess the differences between the pre and post wetland water quality data.
CR5	Immediately upstream of the third wetland complex	Data collected at this site will be compard to the data collected at Site 6 to assess the differences between the pre and post wetland water quality data. The distance between Site 4 and the third wetland complex is approximately 1/2 mile. Thus, site 5 was selected to more accurately reflect the conditions immediately upstream of the third wetland complex.
CR6	Immediately downstream of the third wetland complex located at the mouth of the Chocorua River, adjacent to Chocorua Lake.	Data collected at this site will be compard to the data collected at Site 5 to assess the differences between the pre and post wetland water quality data.
CR7	Deepest fringe of the littoral zone located in the northwest quadrant of Chocorua Lake.	Data collected at this site will monitor Chocorua Lake's reaction to nutrient inputs. This site is located in a segment of Chocorua Lake characterized by extensive riparian vegetation and few scattered homes located approximately 100 meters from the lake. This site will reflect Chocorua Lakes' overall reponse to nutrient loading and will be compared to site 8 (downstream) to assess the degree of nutrient retention in Chocorua Lake.
CR8	Fringe of the littoral zone located immediately upstream of the Chocorua Lake outlet.	Data collected at this site will assess the nutrient content in Chocorua Lake and serve as an in-lake reference site. This in-lake site is surrounded by extensive tree and herbaceous ground cover.

Streamflow measurements, stream channel morphology measurements and staff gauge readings will be collected at sites 1 through 5, on each of the six sampling dates, to compute discharge and nutrient loading values on the respective sampling dates. Due to excessive depth at site 6, no discharge data will be collected at this site.

For all samplers the artificial substrate chosen is Styrofoam insulation (Owens-Corning, 1

Table 12. Sampling Task III Field Sampling Summary

Analyte	No. of sampling locations	No. of samples per sampling date per site	Number of sampling dates	Number of field duplicates	Number of blanks	Total number of samples to lab
Total Phosphorus	8	1	6	1/sample date = 8	1/sample date = 8	64
Soluble Reative Phosphorus	8	1	6	1/sample date = 8	1/sample date = 8	64
Periphyton (chlorophyll a)	8	3	6	1/sample date = 8	1/sample date = 8	160
Orthophosphate	8	1	6	1/sample date = 8	1/sample date = 8	64
Turbidity	8	1	6	1/sample date = 8	1/sample date = 8	64
Conductivity	8	1	6	1 re-measurement/ sampling location	NA	measured *in situ*
Temperature	8	1	6	1 re-measurement/ sampling location	NA	measured *in situ*
Streamflow	5	1	6	1 re-measurment/ sampling date	NA	measured *in situ*

inch thickness). This material has been used successfully for in lake studies in Maine and New York (Ken Wagner, personal communication). The Styrofoam insulation serves as a “growth plate” that will periodically be scraped off with a 2” wide scraper (razor) blade, to remove the periphyton growth, concentrated onto a 0.45 micron mesh filter and subsequently analyzed for the chlorophyll *a* pigment content. Note: the chlorophyll a samples will be scraped under subdued lighting and upon filtration of the periphyton samples the filters will be folded in half and wrapped in aluminum foil to avoid deleterious light exposure. The chlorophyll *a* content will measure the periphyton standing crop that integrates the “long-term” nutrient loading at the respective deployment sites. The periphyton (Styrofoam) samplers are easy to deploy, replace and will facilitate data collection for the duration of this study. The inherent buoyancy of the material also allows for lake deployments without the use of floats that would block out sunlight to the sampler. For stream deployments the material will be cut to 4” by 8” blocks that will be attached to an anchor weight consisting of a similar sized landscape brick (red) using a wire harness. For in-lake deployments a two piece wooden x-frame will be attached with eyebolts that will allow the attachment of anchors and line to maintain the sampler at the selected depth and location. The periphytic algae for chlorophyll *a* analysis will be obtained over a standardized 2” x 4” surface area (51.6 cm^2) by drawing the 2” wide razor blade over the entire width (4”) of the periphyton samplers. This method was chosen instead of employing pre-scribed quadrants on the samplers since we found the marking process creates an indentation in the Styrofoam surface which tends to trap sample. This method approach also allows for negating the impact of grazing insects (i.e. *Heptageneid* mayflies) and the interference of patches of filamentous green algae (*chlorophyceae*) as we will select our transects based on the most representative areas on each periphyton sampler.

All stream samplers will be deployed at approximately the same depth and sun exposure direction in the moderate to low energy area of the stream channel (Barbour et al, 1999). All in-lake samplers will be deployed at depth of one meter in an area away from dense plant beds. Other multiple deployment periphyton studies have been criticized for comparability between sites due to temperature and sunlight differences. We will thus monitor incident light, temperature and humidity on a data logger (Onset Computer Corporation Model HO8-004-02) fitted into a clear waterproof submersible case (SUBCASR-CLR) at each deployment site. The data logger will be attached to the periphytometer so it remains downstream and does not shadow the monitor. The temperature and light logs will be used to compare the conditions facing the samplers. The relative humidity measurement will monitor the water tightness of the case. Specifications of these sensors are listed below (Table 13).

TABLE 13. Specifications of the Onset Model HO8-004-02 (provided by manufacturer)

Measurement Range	*Accuracy*
Temp: -4°F to +158°F	**Temp:** ±1.27°F
RH: 25% to 95% non-condensing	**RH:** ±5%
LI: 2 to 600 Lumens/ft2	**LI:** ±2 lumens/ft2

9.0 Sampling Procedures and Requirements

9.1 Sampling Procedures

9.1.1 Task I: Post BMP Installation Monitoring/Evaluation of Route 16 Culverts.

The Route 16 culvert samples will consist of the collection of TP, TN and TSS samples as well as the collection of specific conductivity (SPCD), turbidity, streamflow and stream morphology data during each sampling trip (Table 8).

The temperature and SPCD data will be collected in-situ at all sites along the sampling stations. The temperature and SPCD measurements will be recorded on the "Chocorua Lake: Rt 16 BMP Monitoring/Evaluation datasheet" (Appendix D).

Soluble reactive phosphorus, TP, TN, TSS and turbidity grab samples will be collected in the appropriate sampling bottles by pointing the bottles upstream and carefully placing the bottles into the water and allowing the bottles to fill. If the field technician inadvertently disturbs the benthic substrate during the collection process the sample will be discarded, the contaminated sampling bottle will be deemed unusable and the collection procedure will be repeated with an uncontaminated bottle by collecting a water sample 10 cm upstream of the previous sampling location.

The Chocorua Lake culvert sampling will be conducted during or immediately following rainfall events during which peak runoff and peak phosphorus and sediment loading typically occur. The CFB field team will attempt to collect the phosphorus samples during the most intense rainfall period although the sampling period might include the collection of samples immediately following the storm event.

9.1.2 Task II: Deep Lake and Major Tributary Sampling.

Grab total phosphorus data will be collected at the deep in-lake sampling location as well as near-shore sampling locations located at the major tributary inlet (Chocorua River) and at the Dam (outlet). The TP samples will be collected from a canoe at pre-determined coordinates through triangulation. The canoe will be securely anchored at the appropriate sampling location and a water sample will be collected at a depth of 0.5 meters using a vertical Van-Dorn sampler. The Total Phosphorus samples will be frozen at -20^{o}C until subsequent analysis (Table 14).

9.1.3 Task III: Integrated Nutrient Sampling of Pre and Post Wetland Impacts.

Artificial periphyton colonization substrates will be placed at stream sites after the period of

Table 14 Sample locations and requirements

Analytical Parameter	Collection Method	Method SOP	Sample volume/ area	Container size and type	Preservative	Max. holding time and storage requirement
Chlorophyll	AFS *	9.1c	51.6 cm^2	NA *	NA	28 days @ -20^{o}C
Total Phosphorus	grab	9.1a	250 ml	PP	H_2SO_4 to pH<2	28 days @-20^{o}C
Soluble Reactive Phos.	grab	9.1a	250ml	PP ^	NA	7 days @-20^{o}C
Total Nitrogen	grab	9.1a	250 ml	PP	H_2SO_4 to pH<2	28 days @-20^{o}C
Turbidity	grab	9.1a	2 Liters	PE	NA	24 hrs @4^{o}C
Total Suspended Solids	grab	9.1a	2 Liters	PE	NA	24 hrs @4^{o}C
Conductivity	in-situ	9.1a	NA	NA	NA	NA
Temperature	in-situ	9.1a	NA	NA	NA	NA

* denotes samples will be scraped from an artificial substrate (AFS) and subsequently filtered onto a 0.45um HAWP04700 Millipore membrane filter. A Nalgene hand pump will be transported into the field, where the samples will be filtered. The samples will subsequently be placed loosely in plastic bags containing Drierite and place in a ice-filled cooler.
^ SRP samples will be field collected in 500 ml acid washed PP bottles and filtered through Millipore HAWP04700 membrane filters immediately upon return to the CFB laboratory. The filtrate will be collected in a 250ml acid washed bottle and stored at –20^{o}C until analysis. All filtration equipment will be acid washed prior to use.

peak spring runoff. The artificial substrates will be positioned at a similar depth and direction to sunlight exposure, at a slight angle to deter sediment settlement, in an inconspicuous place to minimize interference or vandalism. The artificial substrates will also be marked do not disturb and information for returning found samplers will be attached. In-lake periphyton samplers will be deployed at the same time. Every two weeks the samplers will be checked, the substrate will be digitally photographed to show coverage patterns, the loggers will be downloaded and a subsample of the substrate will be scraped and the algae collected.

Periphyton will be collected using a straight edged blade to scrape off a predetermined area of accumulated algae into a filtration flask containing a 47mm diameter 0.45 micron Type HA Millipore membrane filter. The scraped area and blade will be rinsed with distilled water into a Nalgene filtration flask (Cat # 310-4000) to collect the periphyton sample. The rinsate will be field filtered through a Millipore membrane by applying a vacuum generated by a Nalgene hand vacuum pump. The filter will then be placed on the back of an archive quality (acid-free) paper insert label

containing the sample information written in pencil. The filter and insert label are then placed into an opaque plastic container with Drierite desiccant and placed on ice in the field until it can be transferred to a freezer. Information written on the insert label will be repeated on the field sheet to include date, time of sampler removal, scraping and re-deployment, sample number, site number, field personnel, area scraped and comments. Prior to the periphyton sampler re-deployment, all remaining algae will be cleaned and scrubbed off, or a new substrate will be deployed.
At least 5% of all samples collected will be field duplicates. Occasionally other samples of the periphyton may be collected for later identification but that is beyond the intended scope of this project. Frequency of sampling is expected to be every other week but might be modified dependent on actual growth conditions.

SRP, TP and TN and turbidity grab samples will be collected in the appropriate sampling bottles by pointing the bottles upstream and carefully placing the bottles into the water and allowing the bottles to fill. If the field technician inadvertently disturbs the benthic substrate during the collection process the sample will be discarded, the contaminated sampling bottle will be deemed unusable and the collection procedure will be repeated with an uncontaminated bottle by collecting a water sample 0.5 meters upstream of the previous sampling location.

9.2 Sampling SOP Modifications

No SOP modifications are required in this project.

9.3 Cleaning and Decontamination of Equipment/Sample Containers

All digital field-sampling probes will be thoroughly rinsed with de-ionized water before each sampling trip and immediately upon return to the laboratory. The pre-calibration and post-calibration of all digital sampling equipment, and accompanying pre-calibration and post-calibration logs, will assure the sampling equipment has been properly cleaned and inspected.

All sample bottles will be rinsed three times with reagent grade de-ionized water. The nutrient sampling bottles will be washed in a 30% hydrochloric acid solution prior to the de-ionized water rinse to assure the sampling bottles are appropriately prepared for trace nutrient concentrations.

9.4 Field Equipment Calibration

The YSI 30 temperature probe will be checked and inter-calibrated, using an NIST certified thermometer, at the beginning and the end of this project, as well as, whenever the batteries are changed. A calibration check will also be performed after each sampling trip to assure the digital temperature meter has not drifted by more than 0.1^oC. If readings differ by more than 0.1^o C the discrepancy will be noted on the instrument calibration maintenance log and the meters will be re-adjusted and calibrated per the manufacturer’s instructions. The acceptance criteria for the temperature data will be set as <= 0.2^oC. All temperature data that exceed our acceptance criteria, collected since the last acceptable calibration check, will be considered suspect and will be discarded.

The YSI 30 specific conductivity probe will be calibrated immediately prior to each sampling trip, and whenever the batteries are changed, per the manufacturer specifications outlined in Appendix B. A set of calibration standards will also be analyzed at the end of each sampling trip to assess the degree of “drift”.

The Global Flow FP101 will be calibrated whenever the batteries are changed per the manufacturers "Set Up" directions (Appendix B - 3). A lab technician will also calibrate the Global Flow FP 101 streamflow meter immediately prior to each sampling trip. All calibration checks will be documented in the calibration/maintenance log (Appendix C).

The temperature data measured with the Onset HO8-004-02 meter will be compared to a NIST certified thermometer before deployment. If the temperature readings differ by more than 1.3°C the discrepancy is noted on the instrument calibration maintenance log (Appendix C) and the temperature is adjusted by a professional technician. The emphasis here will be more to standardize the loggers among one another, as consistency among the meters is critical in doing the compensation for the physical conditions among the periphyton (Task III) sampling sites. The Onset Model H08-004-02 temperature readings are compared to temperature readings obtained with a NIST certified thermometer after they are retrieved at the end of the study. Discrepancies between the values measured with the Onset Model H08-004-02 meter and the NIST certified thermometer will be documented in the calibration log.

9.5 Field Equipment Maintenance, Testing and Inspection Requirements

As part of our routine inspection and preventative maintenance program the laboratory manager, Bob Craycraft, conducts a variety of tests on our laboratory and field equipment and the data are recorded on a maintenance log (Appendix C). Maintenance, repair and adjustments that require a professional technician are conducted by either our instrument repair facility located at the University of New Hampshire Department of Chemistry or by authorized factory technicians of the particular instrument's manufacturer. All maintenance manuals, documentation and schematics as well as the instrument logs are kept on file by the CFB laboratory manager.

On a monthly basis all electronic cables will be checked for stretching, twists and breaks. Cable and line markings that indicate depth will also be checked at this same frequency.

Probes for field and laboratory instrumentation will be visually checked before and after each use. Replaceable components such as electrolytes and membranes will be replaced on a schedule consistent with manufacture's recommendations unless inspection or performance indicates a need for more frequent replacement. Fresh solutions and membranes are kept on hand in the lab and in the field. A replacement probe for each instrument is always available. Expendable and refurbishable probes are used up to the recommended times of their manufacturers specifications and will be replaced or refurbished at the beginning of this project.

9.6 Inspection and Acceptance Requirements for Supplies/Sample Containers

Conductivity standard reference materials (SRMs) are dated upon receipt and are stored per the manufacturers recommendations. These dates are checked against manufacturers expiration dates and the materials are discarded before the expiration dates are reached. The standards used by our laboratory are NIST certified or certified (analyzed) by the supplier (Fisher Scientific or Sigma Chemical) as NIST traceable. Any broken, unsealed or suspect materials are returned to the manufacturer for replacement. When SRM is used it is compared to the previous SRM supply to check for consistency/contamination.

Any sample bottles that appear damaged and any bottles with broken seals or caps are not used for sample collection. If there is any doubt that a sampling bottle was adequately washed it will be set aside and rewashed to assure all contaminants have been removed.

10.0 Sample Handling, Tracking and Custody Requirements

10.1 Sample Collection Documentation

Standardized field datasheets will be used to provide a consistent sample identification and tracking system and to assure the appropriate data are collected.

10.1.1 Fieldnotes

Four different sheets will be used in this study (Appendix D 1-5) and they include the following information:

Task I: Post BMP Installation/Monitoring/Evaluation of the Route 16 Culverts - names of the field technicians, date, site, time, current precipitation, temperature, specific conductivity, culvert depth, culvert diameter and stream flow. There are also “check off” boxes to specify the collection of total nitrogen, total phosphorus, total suspended solids and turbidity samples while spaces for the respective analyte concentrations are provided and are filled subsequent to laboratory analysis.

Task II: Deep Lake and Major Tributary Sampling - names of the field technicians, date, site, time, temperature and specific conductivity. There are also “check off” boxes to specify the collection of soluble reactive phosphorus, total phosphorus, turbidity and periphyton (chlorophyll) samples while spaces for the respective analyte concentrations are provided and are filled subsequent to laboratory analysis.

Task III: Integrated Nutrient Sampling of Pre and Post Wetland Impacts - volunteer monitor names, site, date, sampling time and a check-off box to indicate the collection of a total phosphorus sample. There is also space provided for the total phosphorus concentration that is filled out following laboratory analysis.

10.1.2. Field Documentation Management Systems

All datasheets (described above) are submitted upon return from the field or upon delivery of water quality samples. The datasheets are compiled in three ring binders housed in the CFB laboratory and maintained by the Laboratory Manager.

10.2 Sample Handling and Tracking System

In the field: sample bottles are labeled with indelible marker and include the lake name, site name, collection time, collection date, and the sampler’s initials. Numbers are not assigned to the field samples unless replicates are being collected, in which case a #1, #2, etc. system will be used to indicate the samples and the order in which they were taken. Samples will be preserved and sealed appropriately as described above and placed in a sample cooler with crushed ice. The cooler is sealed and transported to the University of New Hampshire CFB laboratory by a field team member following completion of the water quality sampling trip.

In the laboratory: Upon return to the laboratory the cooler contents are checked against the field sheets to account for all collected samples. Samples are then placed under the appropriate storage conditions until analysis in the University of New Hampshire CFB (Figure 9).

All samples are kept at 4°C in the field and between laboratories. In the UNH CFB laboratory the samples are warmed to 20°C for analysis. See Table 14 for sample container and sample volume specifications and for preservation and holding time information.

Figure 9. Sampling Handling/Tracking/Custody Summary

Field Collection
↓
Drop-off to CFB Laboratory
↓
CFB Laboratory Log-in and field sheet collection
↓
Sample Analyses
↓
Record Data
↓
Sample Disposal

10.3 Sample Custody

Samples collected by CFB field team members will be hand delivered to the CFB laboratory staff, checked against the field datasheets to assure all samples are accounted for, stored and subsequently analyzed per the storage and holding time requirements that are summarized in Table 14. The Chocorua Lake Task II samples, collected by the volunteer monitors, will be hand delivered to the CFB laboratory staff, checked against the field datasheets to assure all samples are accounted for. Once all samples are accounted for, the volunteer monitor and the CFB Laboratory staff member will both sign the chain of custody sheet (Appendix D-3).

11.0 Field Analytical Method Requirements

11.1 Field Analytical Methods and SOPs

<u>11.1.1. Periphyton Samplers</u>

After the periphyton samples are collected in accordance with sampling Task II, data will be downloaded from the HOBO H08-004-02 (temperature/light meters) during each stream visit (approximately two weeks) using an HPO Shuttle (part # H09-002-08). At the site, the field technician will carefully remove the temperature/light meter from the water without touching the upper half of the protective waterproof case (leave the biofilm intact). Place the meter on a flat surface immediately adjacent to the in-stream sampling location and allow the meter to record incident light for a period of 5 minutes. After the 5 minute recording period, remove the meter from the clear submersible case (Part # SUBCASE-CLR) and place the meter on the ground for an additional 5 minute period and allow the meter to record the incident light. The incident light data collected over the 5-minute intervals will help determine any light loss due to fouling over the course of the prior two-week deployment period. While the light meter is recording incident light you should rinse off the clear submersible case using de-ionized water (DI H_2O), dispensed from a Nalgene squirt bottle, and wipe the case with paper towels. Make sure all fouling agents have been removed from the protective case, and make sure the inside of the case is dry, prior to unit redeployment. After recording the post-deployment incident light (with and without the case) insert the download cable into the data transfer interface. Once a connection has been established between the shuttle and the temperature/light meter initiate the data transfer button and wait for the "successful" light to turn orange next to "successful" on the side of the shuttle. If a "comm failure" message indicator appears remove the download cable. Patiently repeat the above steps until the data are downloaded. Once the data are successfully downloaded, select "relaunching" from the menu (the orange light will blink if successful) and carefully insert the HOBO temperature/light meter into the submersible case. Reattach the waterproof case to the periphyton sampler. Note: make sure you insert the light sensor face up, otherwise data will be lost. Before leaving the site make sure the waterproof case is vertical and the periphyton sampler is in its origional location.

11.1.2. Temperature and Conductivity Measurements

The most downstream sampling site will always be sampled first, followed by the next sampling location immediately upstream until the entire stream/culvert stretch has been sampled. The field technicians will always stand downstream of the sampling location when collecting the water samples or conducting in situ sampling. Prior to collecting in situ temperature and conductivity measurements contaminants will be cleared from the probe by dipping the probe in the water three times at each sampling location. The probe will then be placed in the water at a depth of 4-6 inches and allowed to stabilize, the reading will be recorded on the corresponding datasheet. The temperature/conductivity probe will then be raised out of the water and then placed back into the stream to obtain a second set of measurements that will be recorded on the corresponding datasheet.

11.1.3. Discharge Measurements

Sampling Task I and II stream channel (culvert) dimensions will be collected by measuring the culvert diameter and the culvert depth and recording those values on the corresponding datasheet. Prior to attaining the flow measurements inspect the Global Flow FP101 propeller to assure it turns freely prior to every measurement. If necessary, rinse the meter with water to remove any particulate debris. A streamflow measurement will be collected by positioning the tip of the velocity meter at six tenth of the stream depth (i.e. if the water is 10 cm deep the tip of the meter should be positioned at a water depth of 6 cm) and following these steps:

1) Point the arrow (on the bottom of the probe) downstream.
2) Press the right button until the "V" for velocity appears. The top number is the instantaneous velocity. Push the left button to toggle between maximum "mx" and the average "av" velocity. The probe will be set to the "av" velocity setting.
3) Push both the right and left buttons simultaneously and release the buttons to zero the meter and begin recording the average velocity measurement

4) Collect the velocity measurement for a minimum of 40 seconds or until the average velocity stabilizes. A stable velocity measurement is one that varies by no more than 10% over a 10 second period.
5) Record the velocity measurement on the datasheet.

11.2 Field Analytical Method/SOP Modifications

No SOP modifications.

11.3 Field Analytical Instrument Calibration

Refer to section 9.3.

11.4 Field Analytical Instrument/Equipment Maintenance, Testing and Inspection Requirements

All field Analytical Instruments will be checked for "low battery" indicators immediately prior to each sampling trip and upon return to the laboratory (post sampling). When the "low battery" indicator appears the laboratory technician will replace the batteries.

Maintenance, repair and adjustments that require a professional technician are conducted by either the instrument repair facility located at the University of New Hampshire Department of Chemistry or by authorized factory technicians of the particular instrument's manufacturer. The YSI 30 cable will be checked before and after each sampling trip and checked for stretching, twists and breaks. If the YSI 30 temperature readings differ by more than 0.1^{o}C, relative to an NIST thermometer, the discrepancy is noted on the instrument calibration maintenance log and the temperature is adjusted by a professional technician.

When temperature readings, collected with the Onset Model H08-004-02 temperature meters, differ from an NIST certified thermometer by more than 1.3^{o}C the discrepancy is noted in the instrument calibration maintenance log and the temperature is adjusted by a professional technician.

11.5 Field Analytical Inspection and Acceptance Requirements for Supplies

Field calibration solutions are dated upon receipt. These dates are checked against manufacturers expiration dates and the materials are discarded before the expiration dates are reached. The calibration solutions used are standard reference materials (SRMs) that are NIST certified by the supplier (Fisher Scientific or Sigma Chemical) as NIST traceable. Any broken, unsealed or suspect materials are returned to the manufacturer for replacement.

12.0 Fixed Laboratory Analytical Method Requirements

12.1 Fixed Laboratory Analytical Methods and SOPs

In most cases, the procedures used in the laboratory will follow standard methodology as described in Standard Methods for the Examination of Water and Wastewater (APHA, AWWA, WPCF 1998; 20th edition) or Methods for the Chemical Analysis of Water (US EPA 1999). Our second derivative spectrophotometric total nitrogen procedure is currently scheduled to be included in the upcoming release (21st edition) of Standard Methods so alternatively, the techniques documented in peer reviewed journals will be employed (Appendix D). Table 7 summarizes the parameters to be analyzed and the analytical reference sources. Appendix A includes a series of analytical procedure sheets that are used to assure consistency among our laboratory technicians.

Nutrient and chlorophyll data will be measured on highly sensitive spectrophotometers (bandwidth <= 2nm) using cuvettes with 5 – 10 cm pathlengths as outlined in Table 15. These highly sensitive spectrophotometers facilitate the collection of chlorophyll data and also maximize the sensitivity of other analytes that are analyzed in the CFB laboratory.

Table 15. Laboratory Spectrophotometers and analytical criteria for study analytes

Spectrophotometer	Analyte Measured	Bandwith	Cuvette Type	Cuvette Pathlength
* Cary 50 Scanning Spec.	Total Nitrogen	1.7 nm	Quartz	5 cm
* Milton Roy 1001+	Chlorophyll	2.0 nm	Near UV	5 cm
* Milton Roy 1001+	Total Phosphorus	2.0 nm	Near UV	10 cm
* Milton Roy 1001+	Soluble Reactive Phosphorus	2.0 nm	Near UV	10 cm

12.2 Fixed Laboratory Analytical Method/SOP Modification

The extraction of the periphyton (chlorophyll) samples has been modified from the APHA Standard Methods: 100200H.1 (APHA, 1998) to maximize the rupture of algal cells and to maximize the subsequent extraction of the chlorophyll pigments. The final analysis of the chlorophyll extract does follow Standard Methods: 100200H.2 (APHA, 1998).

Chlorophyll Extraction:

1) Frozen samples will be analyzed within 28 days of collection.
2) Algal cells will be disrupted in a glass centrifuge tube using an ultrasonic probe while held in an ice-bath.
3) The algal samples will be brought to 15 ml volume with 90% acetone and allowed to “steep” refrigerated for 24 hours in the dark.
4) Samples will be centrifuged and analyzed according to Standard Methods: 100200H.2 (APHA, 1998).
5) Chlorophyll biomass will be measured spectrophotometrically and calculated as micrograms chlorophyll *a* per square centimeter by taking account of area of periphytometer scraped, volume of extract, absorbtivity of the chlorophyll a molecule in 90% acetone, and pathlength of the cuvette.
6) The chlorophyll *a* results will be generated using the monochromatic spectrophotometric equation with a pheophytin correction:

$$\text{Chlorophyll } a = \frac{26.7 * (664_b - 665_a) * \text{extract volume}}{\text{Sample volume} * \text{path length}}$$

where b = before acidification
a = after acidification

12.3 Fixed Laboratory Instrument Calibration

Before each use the spectrophotometer is inspected and the light path optics of the sample cuvette are cleaned with lens paper. At the beginning of each analytical run, a series of predetermined standards are used to generate a multi-point initial calibration curve (Appendix A). During use, calibration blanks are re-run to check for instrument drift after every ten sample readings and at the end of each sample run. If significant drift occurs (a difference greater than 0.001 Absorbance units), the instrument is re-calibrated, blanked and the samples are re-run. Any occurrences are noted in the instrument log (Appendix C).

12.4 Fixed Laboratory Instrument/Equipment Maintenance, Testing and Inspection Requirements

The laboratory spectrophotometers undergo preventive maintenance checks by our University of New Hampshire Instrument Technician on a yearly basis. This covers wavelength accuracy, mirror alignments, lamp alignments and a cleaning of the sample compartment and light path area. Alignments are also done when replacement of a lamp is necessary. The internal self diagnostic check is run on a monthly basis. This procedure indicates if the electronics are working properly and also if the lamps are functioning properly or are in need replacement.

Performance is evaluated during each sample run by measuring a series of calibration standards and conducting a replicate from samples already run after every ten samples and at the end of the run. If a discrepancy is found, the instrument is re-calibrated and samples are re-run.

12.5 Fixed Laboratory Inspection and Acceptance Requirements for Supplies

Laboratory reagents are dated upon receipt. These dates are checked against manufacturers expiration dates and the materials are discarded before the expiration dates are reached.
Standards used are SRMs that are NIST certified or certified (analyzed) by the supplier (Fisher Scientific or Sigma Chemical) as NIST traceable. Any broken, unsealed or suspect materials are returned to the manufacturer for replacement. When a new container of SRM is used it is compared to the previous SRM supply to check for contamination.
All sample bottles are prepared according to standard methods.

13.0 Quality Control Requirements

13.1 Sampling Quality Control

Flow measurements:

During each sampling trip a minimum of two readings will be duplicated by two different field technicians to assess the precision of the measurements. The measurements collected by the two different field technicians will also assess the consistency among our field team staff. If the duplicate readings differ by more than 10%, the field technicians will discuss the procedures with the Project Manager until an understanding is reached. Suspect measurements might be discarded or might be kept depending on the result of the conversation. Duplication will also occur when Staff gauge readings (previously installed for the nutrient budget project) will be collected to document the stream depth for each gauged point. The staff gauge height and concurrent streamflow/culvert geometry measurements, collected during each sampling trip, will be used to assure the gauge height/discharge relationship is accurate. If a heavy runoff event alters the stream channel morphology, a new rating curve will be generated for the applicable (post channel alteration) time period.

Sample collection:

Field duplicates will be collected at least once during each field sampling trip and will account for a minimum of 5% of the collected samples during a single sampling trip. Precision will be calculated using the RPD between the replicate samples. If the RPD exceeds the MPC (Table 6), the sample results will be considered questionable and the Project Manager will consult the UNH laboratory manager to determine if the data quality has been compromised, in which case the suspect results will not be used.

13.2 Analytical Quality Control

13.2.1 Field Analytical QC

Replicate in-situ measurements will be measured on 100% of the samples. If the precision outlined in Table 6 is exceeded the sample results will be considered questionable and the Project

Table 16. Fixed Laboratory Analytical QC Sample Table

Analyte	Laboratory Duplicate	lab fortified matrix spike	lab fortified blank (QC Standard)	lab reagent blank
Total Phosphorus	100%	5%	B & E *	B & E *
Soluble Reactive Phosphorus	100%	5%	B & E *	B & E *
Total Nitrogen	100%	5%	B & E *	B & E *
Turbidity	100%	NA	B & E *	B & E *
Total Suspended Solids	10%	NA	B & E *	B & E *

* B and E denotes QC standards and reagent blanks will be analyzed immediately after instrument calibration at the beginning (B) and the end (E) of each analytical run.

Manager will consult the UNH laboratory manager to determine if the data quality has been compromised, in which case the suspect results will not be used.

13.2.2 Fixed Laboratory QC

Table 16 summarizes the Fixed Laboratory QC SOPs that are employed by the University of New Hampshire CFB laboratory. The table lists the minimum level of replication, lab reagent blank analysis and lab fortified matrix spike analysis while more frequent QC samples might be run at the discretion of the laboratory manager.

Replicate turbidity measurements will be measured on 100% of the samples. If the RPD is greater than 15% the sample results will be considered questionable and the Project Manager will consult the CFB laboratory manager to determine if the data quality has been compromised, in which case the suspect results will not be used.

14.0 Data Acquisition Requirements

Historical total phosphorus, specific conductivity, temperature and discharge data were collected during a Chocorua Lake water/nutrient budget between 1996 and 1997 (Schloss, 2000). The water quality data generated during the nutrient/water budget will serve as baseline data for the proposed Chocorua Watershed Project Phase II study. Data collected during the 1996/1997 Chocorua Lake nutrient budget included sampling of the Rt 16 drainage culverts (Figures 4 and 5) as well as the sampling of various points along the Chocorua River (Figure 7; Sites 3-5) that will serve as baseline data for this proposed study. Additional total phosphorus, total nitrogen, soluble reactive phosphorus, TSS, turbidity, specific conductivity, temperature and discharge data have been collected in the Rt 16 drainage culverts (figures 4 and 5) and at the Chocorua River sampling sites (Figure 7; Sites 1-8) have been collected since 1997 (data unpublished). These supplemental physio/chemical data have been collected during various stages of the BMP implementation adjacent to Rt 16 and will help assess the ability of the Task I BMPs to attenuate pollutants. Data collected at the periphyton sampling sites (Task II) since 1997 will serve as a baseline to better understand the nutrient and physical changes that occur as the water travels from the headwaters to the mouth of the Chocorua River and as the water flows from the north to southern end of Chocorua Lake. Preliminary periphyton data collected at the proposed Task II sampling locations in 2001 will also be used to assess the functionality of the wetland complexes at attenuating nutrients as well as provide some indication of interannual periphyton biomass (measured as total chlorophyll) variations.

Daily precipitation data, collected by the National Oceanic and Atmospheric Administration at the Tamworth 3 and Tamworth 4 climatological sampling stations (National Oceanic and Atmospheric Administration: http://cdo.ncdc.noaa.gov/plclimprod/plsql/poemain.poe), have been used to calculate water and phosphorus loading values at the Chocorua Lake tributary sampling sites between 1996 and 2002. A supplemental HOBO rain gauge was deployed approximately 0.25 miles west of Chocorua Lake in September 2001 (Figure 2). The HOBO rain gauge collects rainfall data in 0.01” increments and will be used to more accurately assess the ambient rainfall within the Chocorua Lake watershed during the proposed Phase II study period.

Historical water quality data collected by the UNH LLMP since 1982 (Craycraft and Schloss, 2002) will provide an in-lake record of the water transparency and total phosphorus content documented in Chocorua Lake. These data will provide a long-term record of water quality parameters to which the in-lake water transparency and total phosphorus data, generated through the current study can be compared. Supplemental Chocorua Lake data historically collected by the New Hampshire Fish and Game Department (Hoover, 1938; Newell, 1970) and the New Hampshire Department of Environmental Services (Estabrook et. al., 1993; New Hampshire Water Supply and Pollution Control Commission, 1981) will also be reviewed and will serve as baseline data. Care will be taken when comparing the results among studies due to methodological variations and differences in the sampling frequencies. Differences between data generated in the proposed Chocorua Watershed Phase II project and the historical data will be included in the final summary report.

15.0 Documentation, Records and Data Management

15.1 Project Documentation and Records

CFB Field Data Sheets (see Appendix D for copies of field and lab data sheets) will be used to record all of the data collected in the field. A field data sheet will be filled out on each sampling date and includes a header indicating the “Chocorua Lake” water quality study task (I, II or III). All datasheets have a space to fill in the sampling date, time and the field technicians who are present.

All datasheets contain spaces to record the appropriate water quality measurements (specific to each datasheet) and/or check off boxes that indicate samples were collected which require laboratory analyses (Appendix D).

Each of the four datasheets contains the pre-determined sampling locations that will assure consistency in data reporting and that will also act as a checklist that will assure all locations have been sampled. The datasheets also contain spaces (next to the check off boxes) for all data that are processed in the laboratory. This will assure all water quality data collected for a specific task, on a specific date, are ultimately compiled onto a single master datasheet that is archived by the CFB laboratory manager.

Samples run through the spectrophotometer at a later date are documented on separate laboratory spectrophotometer data sheets that are specific to chlorophyll, soluble reactive phosphorus, total nitrogen and total phosphorus data (Appendix D). Immediately prior to laboratory analysis, data (i.e. lake, site, collection date, sampling time, sampling depth, etc) are transcribed from the individual sampling bottles to the appropriate spectrophotometer datasheet. Spectrophotometer absorption values, as well as, the analytical date and laboratory technician are also recorded on the laboratory spectrophotometer datasheets for QC purposes. Before sample analytical runs are made, labels will be reviewed and samples with missing information that can not be attributed to the proper sampling location, date and depth will be discarded. Samples not properly preserved and/or samples held beyond the reported holding times will also be discarded (Table 14). Upon completion of the analytical run, the CFB Laboratory Manager and Field Supervisor will perform checks on all calculations and verify QC procedures before the results are transferred to the field data sheets by a laboratory technician. A second laboratory technician verifies that the data were transferred correctly, the lab sheets are marked (a box is checked indicating data transfer/validation) that indicates the data were transferred and the spec log sheets are returned to the appropriate laboratory notebook.

15.2 Field Analysis Data Package Deliverables

Field analytical measurements are generated instantly while concurrent samples are collected for laboratory analysis at a later time. Field measurements are recorded on field datasheets, while subsequent laboratory data are recorded on laboratory (spec) datasheets. The spec data are compiled onto the original field datasheets and the validated data are transferred onto an electronic Microsoft Access database.

15.3 Fixed Laboratory Data Package Deliverables

The original field datasheet, spec logbook and chain of custody documentation will be stored in a file cabinet immediately accessible to the laboratory manager for three years after which the data will be archived for long-term storage.

15.4 Data Reporting Formats

All Field recordings are made in pencil to facilitate data recording during precipitation events. No data are being collected in this project for legal proceedings, therefore there are no set procedures for recording data, other than filling out the datasheets displayed in Appendix D. Field and laboratory data will be recorded in electronic database files, and spreadsheets, designed for this study. There are no standard procedures for format or content. Our electronic data bases are currently being readied for generating output to EPA STORET II pending assistance from EPA New England this coming summer (2003).

15.5 Data Handling and Management

Data Recording. In the CFB laboratory, analytical results are entered into analyte specific spec log books in pencil. A replicate and critical range analysis is performed for 10% of the data. The resulting data are transferred to field datasheets and are entered into a Microsoft Access database where they are queried for data summaries and reports. Queried reports are cross-referenced with the field datasheets (and spec log books) to ensure data accuracy.

Data Transformations/Data Reduction. Data are generally analyzed statistically in the spreadsheet programs, Microsoft Excel (basic descriptive statistics only) and Sigma Plot (SPSS Inc.), to generate basic summary statistics including means, medians, quartiles, standard deviation, minimum and maximum values. When regression analyses are employed the statistical program, JMPIN (version 4.0.3 SAS Institute Inc.) might also be employed. Data transformations are conducted at the end of the Chocorua BMP study after all data are processed and compiled.

Data Transfer/Transmittal. Data are frequently copied and pasted between various programs depending on the need for various statistical analyses and the graphic capabilities of the software. Transferred data are cross-referenced with the original data.

Data Analysis. Most data will be analyzed using simple summary statistics in Microsoft Excel.

Software. The following software will be used to analyze data: Microsoft Excel, SPSS Inc. Sigma Plot/Sigma Stat, JMPIN (SAS Institute Inc.).

Data Assessment. Upon return to the laboratory all field datasheets will be reviewed by the laboratory/field team supervisor and suspicious measurements will be “flagged”. A discussion between the field team supervisor and the field technician will ensue to determine whether or not the suspect data should be accepted.

All water quality data compiled on the field datasheets will be entered onto a Microsoft Access database program by a laboratory technician. A hard copy of the digitized data is generated and the data are manually proofed by two different laboratory technicians (one of the technicians might have input the data). The laboratory manager will make any changes/corrections to the database file.

15.6 Data Tracking and Control

Data collected during this project are generally collected by CFB field technicians and most data are analyzed internally. Thus, the “Chocorua Lake Task I: Post BMP Installation Monitoring/Evaluation of the Route 16 Culverts ”and “Chocorua Lake Task III: Integrated Nutrient Sampling of Pre and Post Wetland Impacts” field datasheets will serve as the sample tracking forms from the field to the CFB laboratory. The “Task II: Deep Lake and Major Tributary Sampling” datasheet that is filled out by the Chocorua Lake volunteer will also serve as the chain of custody sheet to document the transport of samples between the Chocorua Lake Association and the CFB laboratory. All sample transfer documentation will be compiled in three ring binders located in the CFB laboratory and maintained by the CFB laboratory manager.

16.0 Assessment and Response Actions

16.1 Planned Assessments

In order to determine that the field sampling, field analysis and laboratory activities are occurring as planned, the field staff and laboratory personnel shall meet after the first sampling event to discuss the methods being employed and to review the quality assurance samples. All concerns regarding the sampling protocols and analytical techniques shall be addressed at this time and any changes deemed necessary shall be made to ensure the consistency and quality of subsequent sampling. A monthly meeting between the Project Manager and the Laboratory Manager will occur to discuss the sampling progress and discuss results. Additional meetings will be held if necessary.

16.2 Assessment Findings and Corrective Action Responses

The CFB Project Manager will conduct a system and data quality audit after the third round of sampling and immediately following project completion. Any identified procedural problems will be corrected and new calibration standardization procedures and schedules will be put in place if warranted. Review of the CFB laboratory and field technicians will be under the responsibility of the CFB Laboratory Manager and Field Supervisor. Each field team will be accompanied and evaluated by either the CFB Project Manager or the CFB Laboratory Manager and Field Supervisor for at least 50 % of the sampling trips. Field Teams will not go out unsupervised until the CFB Laboratory Manager and Field Supervisor deem them competent. Laboratory technicians will be trained and checked by the CFB Laboratory Manager and Field Supervisor. Only those technicians that produce SRM sample results consistent with project DQOs will be allowed to conduct sample runs. Technicians that do not meet the project DQOs will be re-trained.

The Chocorua Lake volunteer monitors will be accompanied by, and evaluated by, either the CFB Project Manager or the CFB Field Supervisor on the first trip and a trip midway through the year. The volunteer monitors will not go out unsupervised until the CFB Laboratory Manager and Field Supervisor deem them competent. Communication between the CFB Field Supervisor and the Chocorua Lake volunteer monitors will be maintained throughout the study period and additional training will be provided at the discretion of the CFB Field Team Supervisor.

16.3 Additional QAPP Non-Conformances

Corrective actions will be implemented any time that deviations or errors are noted in the field and laboratory work during the project.

17.0 QA Management Reports

Regular status reports shall be made by Jeff Schloss, in the form of correspondence among the Project Manager, Laboratory and Field Team Coordinator and the field staff, will assure the Chocorua Lake BMP monitoring is progressing according to the schedule. Jeff Schloss is responsible for the timely completion of the Chocorua Watershed Project Phase II tasks and the maintenance of the regular status report records.

18.0 Verification and Validation Requirements

Field Data:

If the temperature readings from two in-situ temperature or specific conductivity measurements exceed measurement performance criteria, a note is made on the datasheet. The field technician will inform the field team supervisor of the inconsistency upon return to the laboratory and a decision will be made to accept or reject the data. When data exceed MPC a meeting will be set up between the field team supervisor and the project manager to determine whether additional measurements are warranted during subsequent trips. If the field team supervisor suspects a faulty instrument, the YSI 30 will be shipped to the University of New Hampshire instrumentation center for an assessment.

Lab Data:

Benchtop turbidity analysis - results from equipment blanks, lab duplicates and repeat measurement of at least one of the calibration standards after all sample measurements are made will be used as a basis of validation. If the MPCs are exceeded the data will be discarded and if possible, the instrument will be recalibrated and the samples will be rerun.

Spectrophotometric analyses (Milton Roy 1001+) - data are acceptable only if the drift at the measurement wavelength remains at .001 absorbance units or less. The chlorophyll SRMs, measured monthly, should yield results within 10% of the true value. Laboratory blanks will be analyzed after every eight chlorophyll *a* samples and at the end of each analytical run to assure the spectrophotometer does not drift. For total phosphorus and soluble reactive phosphorous, the results of the standard included in each run should be within 10% of the true value and spiked samples should yield between 90 and 110 percent or the samples will be re-run. The results of the standards included in each Total Nitrogen analysis should yield results within 10% of the true value. The total nitrogen spiked samples should yield between 90 and 110 percent of the predicted value or the samples will be rerun. Any time a total nitrogen, total phosphorus or soluble reactive phosphorus laboratory replicate concentration exceeds 10% (precision) the results will be flagged and the samples will be rerun.

Total suspended solids – Total suspended solids data that exceed 10% precision will be flagged and the samples will be rerun. If a TSS blank measures +/- 0.0005 grams, all total suspended solid samples analyzed with that blank will be flagged and the samples will be rerun.

Data entry – Data entry and data transcription are validated by two laboratory technicians who each proof 100% of the data. Data entry/transcription and calculation errors that are identified will be relayed to the Laboratory Manager who will review the reported errors and make the appropriate changes on the database files. If upon review of the data, gaps, seemingly nonsensical data or outliers appear the CFB Project Manager will flag these data for further review of the supporting documentation including field and lab data sheets, calibrations and maintenance logs, custody forms, QA/QC documentation, and calculations.

For any of the situations described above that do not meet DQO, if samples can not be re-run or re-counted, or satisfactory corrections can not be made then the data will be discarded or qualified at the discretion of the Project Manager and indicated in the interim and final reporting.

19.0 Verification and Validation Procedures

Data sheets will be reviewed for completeness, standard analytical methods will be monitored, samples will be checked for the required preservation and acceptable holding times. After initial review and evaluation, raw data will be summarized and incorporated in report form. At the completion of the study, a final report will be submitted to the DES NPS Coordinator. The report will detail the methods of data collection, results of the field and analytical work and data interpretations in text supported by data tables and graphical references.

20.0 Data Usability/Reconciliation with Project Quality Objectives

While in the field, the Field Supervisor will keep track of equipment and field crew performance. If equipment does not hold calibration or fails, the data collected will be discarded and new measurement will be made after recalibration or equipment adjustment or replacement.
As soon as possible after each sampling event, calculations and determinations for precision, completeness and accuracy are made to implement corrective action if needed. If completeness goals are not met then a resampling visit will be scheduled if time permits and if within the project scope and budget. If other DQOs are not met the data will be discarded and resampling will occur. The cause of the failure to meet DQOs will be evaluated. If the cause is equipment failure, improved calibration/maintenance techniques will be reassessed or equipment will be replaced. A check will be made on documentation of past sampling dates that used the same equipment to make sure it was working properly at those times. If not, the data from those dates will be discarded. If the problem is found to be due to field technician error then that person will be retrained. If data collected by that technician in past field samplings is found to be suspect and cannot be corrected to account for the errors it will also be discarded.

If the failure to meet DQOs is found to be unrelated to equipment, methods or sampling error the DQOs may be revised. Any limitations on data use will be detailed in both interim and final reports and other documentation as needed.

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